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ORIGINAL : ENGLISH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

Agenda Item : C. 6. 4

Switzerland

INSTALLATIONS FOR THE MANUFACTURE OF ANIMAL FOODSTUFFS

By J. AMMANN,
Dipl. Ing. ETH,
Uzwil, Switzerland

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Installations for the Manufacture of Animal Foodstuffs.

by J. Ammann, dipl.Ing.ETH, Uzwil, Switzerland.

Feeding of animals to produce meat, milk or eggs in the most economical manner has become a real science. Today the feed requirements of each animal for each stage of its life are well known, as well as requirements for medication, if any, to keep a herd or flock completely healthy. Optimal values of feed components like carbohydrates, fat, animal and vegetable proteins, minerals, vitamines, roughages have been established accurately. Combination of all factors will produce optimal figures of efficiency and economy in the production of milk, meat or eggs.

To fulfil these known requirements of the animals it is however necessary to revert to a great number of different raw materials which will only in their combination give a properly balanced diet. Feeding animals with a deficient diet will not only reduce the amount of animal products but will also increase the cost of these products considerably.

The raw materials used for the preparation of animal feed vary from country to country. A few of the more common ones are outlined below :

- grains like maize, barley, wheat, oats, sorghum
- oil cakes and oilmeals from soybeans, groundnuts, copra
- meat meal and fish meal
- offals from various industries: flour mills
  starch factories
  sugar refineries
- gras meal

To these many ingredients are added in usually very small proportions to supplement the naturally available raw materials or to obtain some special results:

- vitamines
- minerals
- medications

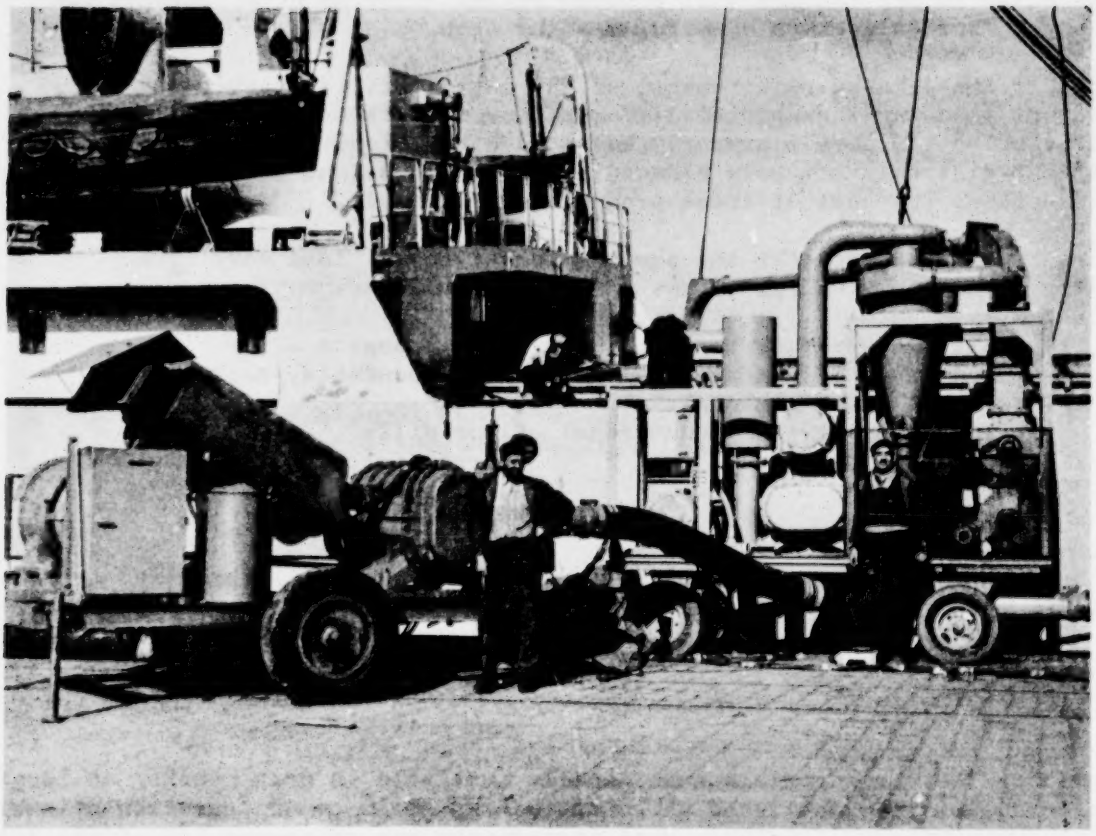
Based upon the raw materials economically available in each country or location feed formulas are established which contain up to 30 or 40 ingredients in widely varying proportions. In fact, some ingredients may represent 1/3 of the total mixture while others may only represent one part in 20 millions.

To proportion and distribute all these ingredients with the necessary accuracy through the mixture, new industrial methods and machines had to be developed and the feed milling industry was created.

Industrial feed mills have to deal with a number of basic problems for which some typical solutions will be shown:

a) Receiving

Many ingredients are normally shipped in bulk and bulk unloading from ships, trucks or cars is becoming of increasing importance. Smaller ingredients, however, are still most economically handled in bags.



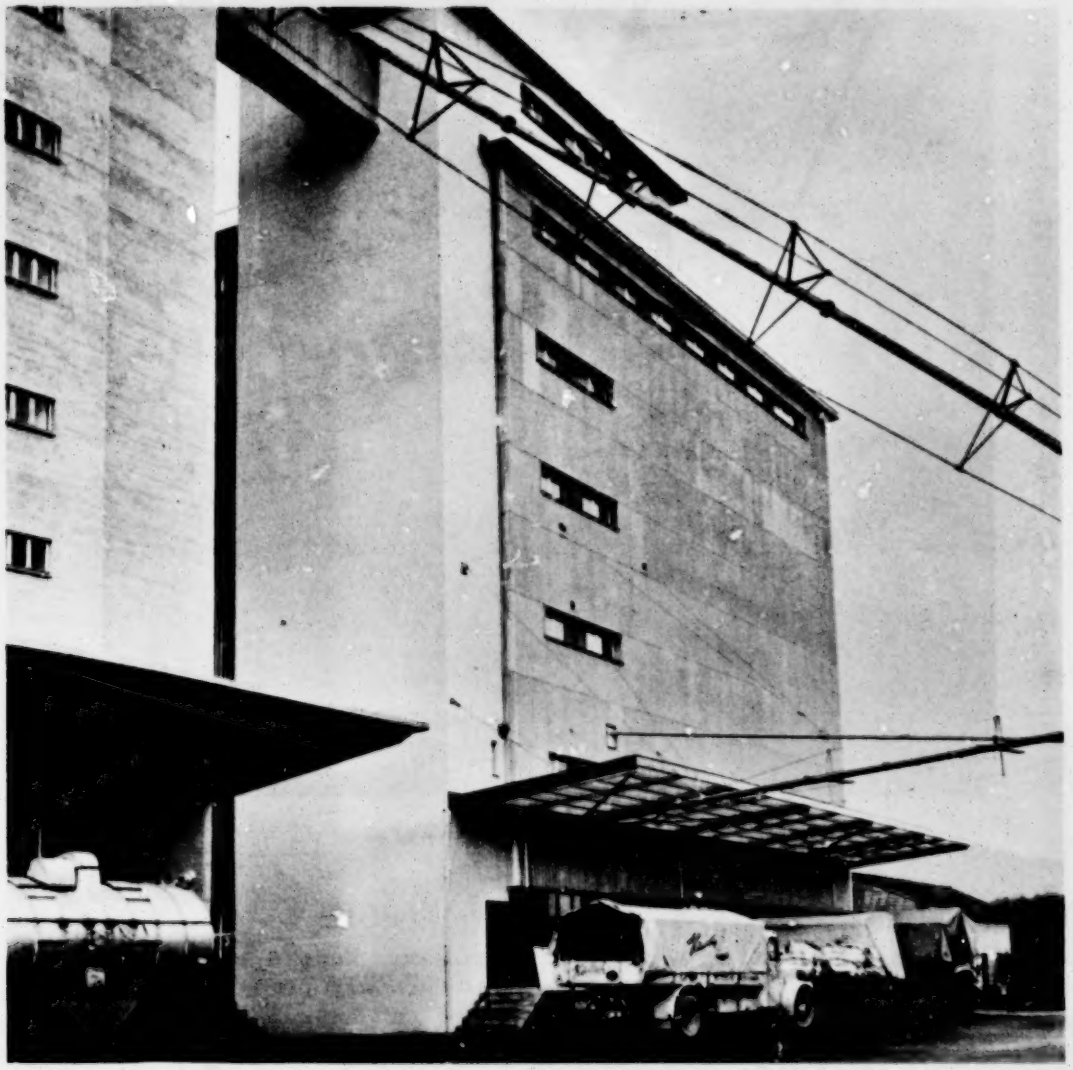
Ship unloading plant.

b) Storage

The methods of storing ingredients will vary according to their nature and importance. For grains conventional silos are in use. Many mealy raw materials (oil meal, mill offals) can be stored in specially adapted silo bins. The size of the storage installation must be determined after careful consideration of the raw material supply.

c) Cleaning

Scalping off course foreign matters is advisable in most cases,

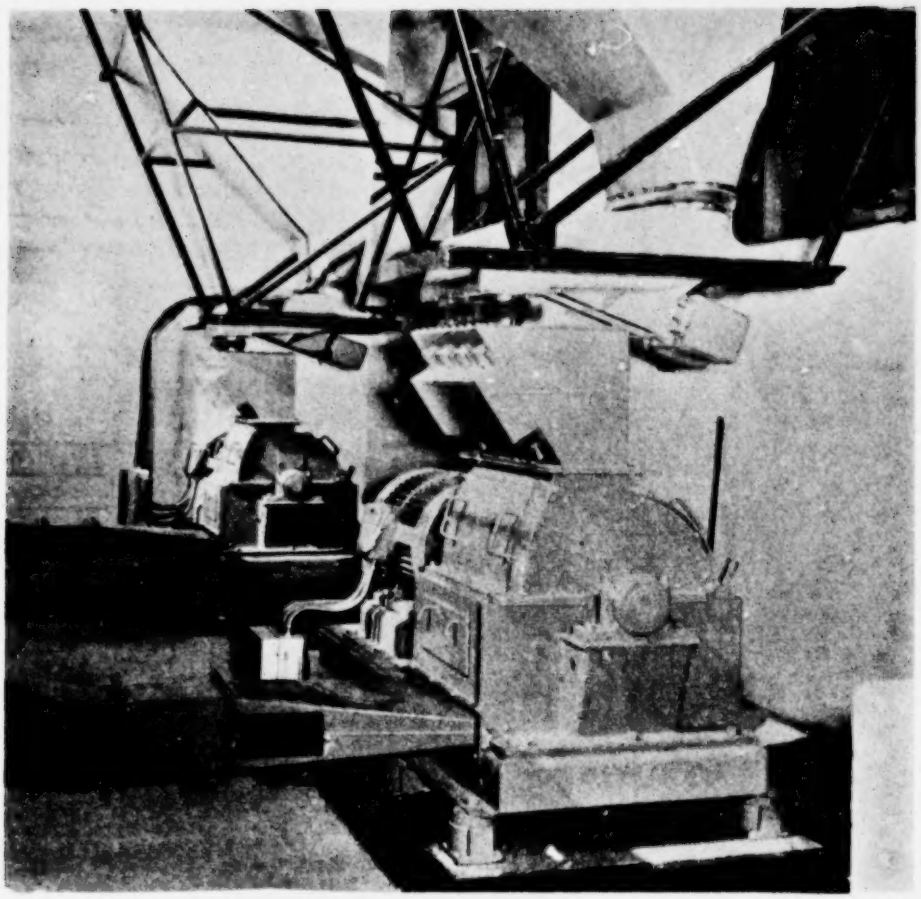


Storage plant for raw materials in meal form

Minor and hard flowing ingredients are kept in bags.

d) Size reduction

Grinding of grains and sometimes oil meals is most economically and flexibly performed with hammer mills combined with suction pneumatic.



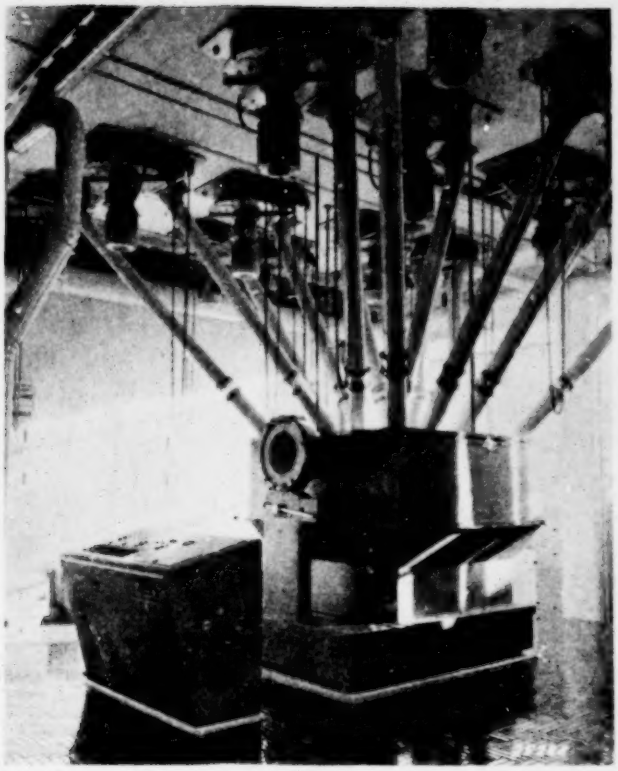
Hammer mill grinding plant.

e) Mixing

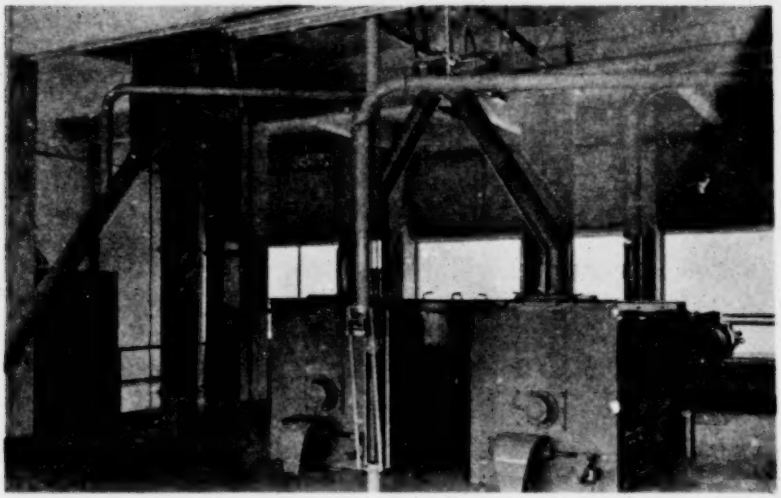
The heart of any feed mill is the mixing plant. Modern installations normally rely upon one or more scales for accurately proportioning the ingredients. Fully automatic punch card systems have been developed to make the mixing process completely independent from the human element and to assure absolutely constant formulations. Batches of 1, 2, 3 tons or more are thus prepared and dumped into a suitable mixer. Extremely small ingredients are normally premixed with some carrier before adding them to the main mixer.

Mixers have been perfected to a point where homogeneous distribution of all ingredients down to one part in 100,000 can be assured after a mixing time of 4 minutes. Homogenity is measured in samples of 10 grams and variations are smaller than 5%.

Output of mixing lines can vary from 5 tons per hour to 30 tons per hour or more.



Fully automatic
mixing plant

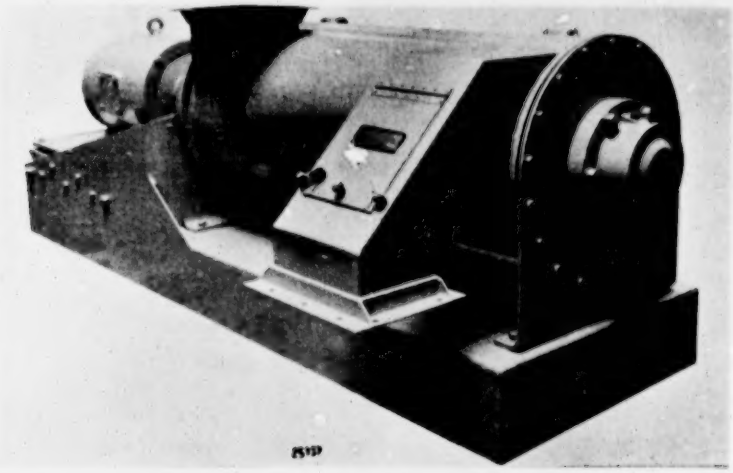


Batch mixers.

f) Molasses Mixer

Molasses and sometimes other liquid ingredients have to be added to the finished mixture by special continuous machines: these high speed mixers prevent any lumps from being formed.

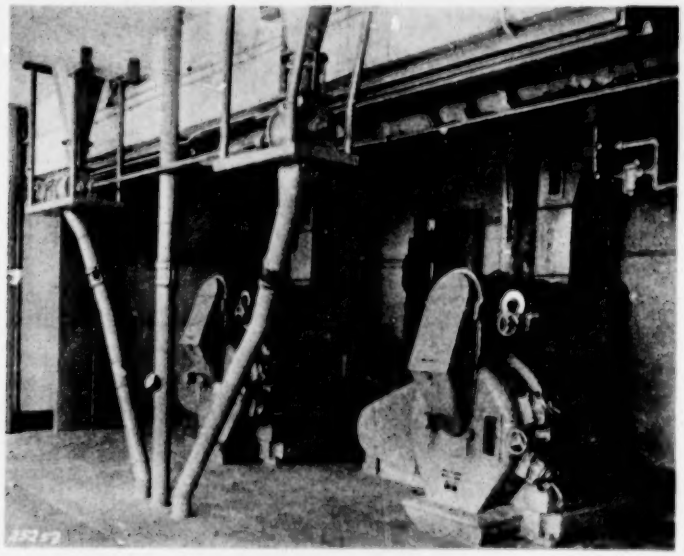
Precautions have to be taken to assure an even flow of molasses and meal to assure accuracy.



Continuous mollases mixer

g) **Pellet mills**

For many applications it has proved advantageous to form a finished feed mixture into solid pellets. Thus the animals cannot separate a once established mixture, feed intake can be higher and less losses will occur because of spillage or dust.



Pellet mills.

h) **Finished products**

Finished products are sold in bags or in bulk depending on the size of the orders.

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SUMMARY

Agenda Item: C.6.4

Switzerland

INSTALLATIONS FOR THE MANUFACTURE OF ANIMAL FOODSTUFFS

By J. AMMANN, Dipl.Ing. ETH,
Uzwil, Switzerland

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Installations for the manufacture of animal foodstuffs

by: J.Ammann, dipl.Ing.ETH, Uzwil, Switzerland

SUMMARY.

Feeding of animals to increase production of meat, milk and eggs has become a science. Feed requirements for each animal are well known today, also requirements for medication, if any, to keep them healthy. Optimal values of feed components like carbohydrates, fat, animal and vegetable proteins, minerals, vitamins, roughages have been established accurately. Combination of all factors will produce optimal figures of efficiency and economy in the production of milk, meat or eggs.

To fulfil these requirements it is necessary to revert to a great number of raw materials, which in their combination give a properly balanced diet. A deficient diet would not only reduce the amount of animal products, but also increase the cost of these products considerably.

A few of the more common raw materials are varying from country to country and are the following:

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Precautions have to be taken to assure an even flow of molasses and meal to assure accuracy.

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Agenda Item:C.1.2

United Arab Republic

AGRICULTURAL CREDIT AND COOPERATIVE ORGANIZATION

By A. El TANAMLI, Ph.D.,
President of the "Crédit Foncier Egyptien"

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AGRICULTURAL CREDIT AND COOPERATIVE ORGANIZATION

A. El Tanamli, Ph.D.
President of the "Crédit Foncier Egyptien"

PART I
GENERAL TRENDS

Supply of Agricultural Credit:

1. Whatever the economic and social system is, the mobilization of funds depends upon the ability of the national economy to collect and direct savings, to meet the production and consumption requirements of those working on the land. Obstacles emanating from the nature of agricultural production and from the positions of the agricultural sector in the national economy, hinder the supply of agricultural credit. The seasonality of income and price fluctuations, the length of production process and special hazards related to this production, the relatively high cost needed to increase the size of a farm, together with the weekness of the agricultural enterprise to attract capital funds constitute some of the most important factors, inherent to the agricultural production, which forge an obstacle for credit supply. As to the position of the agricultural sector in the national economy, it is evident that with economic maturity, the relative importance of the agricultural sector in the national economy diminishes. This phenomenon of the shift from agriculture towards other activities, affects the supply of private funds, including credit for agriculture.

2. Whereas, in the countries following the market economy system, funds for agricultural credit are mobilized through the interaction of market forces; this process is carried out, in countries of collective ownership system, within the public sector and according to the national plan. Agricultural credit in market economy system, is sometimes carried out by the private enterprise, including private Banks, Insurance companies, money-lenders, merchants and intermediaries. The cooperative machinery plays however, an important role. Because of the inefficiency of the private enterprise and of the classical cooperation, to provide adequate credit for agriculture, the gap has to be filled in by the state; either through backing the cooperative organization in a direct manner or by establishing specialized agencies for this very purpose. The central Bank may also be allocated a part in this field.

Case of Under-developed Countries:

3. The level of national and per-capita income is low. The few available savings do not allow the mobilization of sufficient resources for agricultural credit. This is the core of the problem of economic development. In some of these countries, however, the ability to mobilize resources does not only depend on the level of income, but also corresponds to the progress made to establish a monetary economy. Other obstacles, however, stand in the way of agricultural credit supply in under-developed countries. Lack of securities, owing to ownership fragmentation or to defeciency of legal protection, increases risks of agricultural credit and curtails its availability. Moreover, if the process of transformation of the national economy, through investment in non-farming sectors, has been under way, private funds seeking, by their very nature the maximum yield, are tempted away from meeting the credit requirements of the farmers. Banks operating in many of these countries are branches of Foreign Banks. Their activities, carried out in big cities and ports, are almost for trade financing; especially import and export trade. In some countries, however, private foreign capital participated, since the XIXth century, in financing agricultural development.

4. When an under-developed country embarks upon the road of industrial development, need for agricultural credit grows. This is because, in some rural communities, additional income is obtained through a number of manual industries. The farmers are thus enabled to curtail their credit demands. But with economic development and the growth of mechanized industry, rural small-scale industries almost disappear. Rising need for outside finance therefore accrues. On the other hand, industrial expansion by means of public enterprises creates a self generating tendency towards the expansion of the industrial public sectors; and both the relations between the public and private sectors or between the industrial and agricultural sectors are affected, in favour of the industrial public sector (1). In fact an ambitious program of economic development does not only bring about increasing need for new credit requirements; changes in the legal, economic and social institutions, which frequently accompany the execution of such a program, exert substantial influence on the credit market. The agricultural credit system prevailing before these changes take place should be reviewed and adapted. As an example, let it suffice to mention the need for adjustment consequential upon land reform and the restrictions imposed upon private property (I). It seems then incumbent on the state in developing countries, to face the problem of agricultural credit, short and long term.

(I) A. El Tanamli; The role of public enterprises in economic development; contemporary Egypt, , 1962, P.P. 5 - 24.

The Role of Cooperative Societies:

5. Cooperative Societies had their part in Agricultural credit. Agricultural funds were formed by savings contributed by the member farmers. The Society thus formed could borrow by the guarantee of all the possessions of the members. Several such Societies (Raiffeisen) were founded in Germany and Switzerland since the eighteenth century, and spread to many parts of the world in Europe, Asia and Latin America. Some forms of agricultural credit cooperation did not depend upon Government but followed the pace of traditional cooperation; while other forms, such as the system of mutual agricultural credit in France and the system operating in the U.S. of America, under the auspices of the Farm Credit Administration (F.C.A.) function with governmental help. Whereas most of the credit cooperative societies fall under the latter category, it is to be noted that government intervention is still considered, by adherents to the classical conception of cooperation, as a distortion of basic principles. In their opinion, cooperatives must only resort to their own resources.

6. In underdeveloped countries, the cooperative organization is sometimes called upon merely to participate in conveying the distribution of agricultural credit, while money-lenders and merchants still provide the mass of finance. However, the help given by the state is not modest. It is channelled either in the form of direct subsidies to cooperatives or through the central bank or a specialized agency. The state endeavours, furthermore, to make the cooperative machinery share in the collection of resources for agricultural credit. Because of large government intervention, the cooperative organization, in underdeveloped countries, takes forms that cannot be included within the framework of the classical cooperation. The principle of cooperation is made sometimes compulsory.

7. The factors, both inherent in and leading to this evolution are varied and depend upon conditions particular to each country. But we believe that the establishment of a compulsory "cooperative" organization in communist countries and the success of these countries in achieving rapid economic growth are factors underlying the adoption by the developing countries of compulsory forms of cooperation. In addition, where free cooperation flourished, there has been no strict adherence to the classical forms of cooperation; other different forms, not completely conforming to the classical type, were set up. Underdeveloped countries, therefore, did not see any reason to tie themselves to rigid rules, in adapting their cooperative machinery so as to be an effective instrument in the social and economic field. In this, Dr. Horace Belshaw writes:

8. "Indeed the thinking in cooperatives is so much in a state of flux, and so many heterodox ideas are current, as to cause the prophets of the pure and orthodox cooperative gospel to turn in their graves. But, in the environment of under-developed

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1) A. El Tanamli; les Banques de Crédit Foncier en Egypte; L'Egypte Contemporaine, 1959, p. 5-35.
A. El Tanamli; The relations between land reform in underdeveloped countries and economic development programs; L'Egypte Contemporaine, 1956, P. 89.

countries, it would be unscientific to require the rigid application of dogmas, and a pragmatic attitude is called for. The final test is what works. In some cases this requires an explanatory approach to try out ideas and methods before an attempt is made to develop cooperatives on any scale". (I).

PART II

THE U.A.R. PATTERN.

Development of Agricultural Credit in the U.A.R.

9. Agricultural credit has a special importance in the Egyptian economy of modern times. Though the exceptional growth of the Egyptian agriculture, during the nineteenth century, was financed by public funds; long-term credits had their share in financing agricultural development, since the erection of the Asswan dam at the beginning of the XXth century. It also facilitated the distribution of vast areas of arable land among a larger number of proprietors. Due, however, to the impact of the great depression, a number of proprietors failed to pay their debts to real estate banks, and the government intervened to carry part of the burden of debts. The government also tried to organize the supply of short-term credit to agriculture.These attempts culminated in the establishment of the "Credit Agricole d'Egypte" in 1931.

10. As regards the share of the commercial banks in financing agricultural production, before the establishment of the "Credit Agricole d'Egypte", this share was limited, as their activities were principally directed to financing trade, external trade in particular. Although at the present time, these banks extend their credit facilities to different kinds of activities(trade, industry and services), the size of direct credit facilities given to the farmers is still very limited. The National Bank of Egypt (Central Bank) carried particular responsabilities in the development of agricultural credit. It is through the advances of the Central Bank that the "Credit Agricole et Cooperatif," is financed nowadays. It is to be noted, that moneylenders as well as merchants and intermediaries, especially cotton merchants and dealers, have an important part, in credit supply to agriculture. This predominence is not affected by their actual reliance on loans advanced to them by commercial banks.

11. Cooperative societies endeavoured to share in the agricultural credit organization; but always with a limited amount of success; owing to the small size of its resources. Another reason for this limited success was the early maturity of the banking system in Egypt, as , since the closing quarter of the nineteenth century, commercial and real estate banks were established and their activities flourished. Since 1952, increased attention was, for several political and social reasons, paid to cooperation; with the purpose of using cooperative societies as an instrument for the distribution of agricultural credit.

(I) Horace Belshaw; Agriculture Crédit, F.A.O., Rome 1959, P.148

12. The execution of the Agrarian Reform, subsequent to the revolution of July 1952, led to the creation of new types of supervised agricultural cooperative societies of multifarious purposes. Since then, the movement of substituting the cooperative organization, for other forms of economic organization, crystallized in a unique manner.

13. The historical evolution of agricultural credit reveals three stages. The first stage covers the period preceding the establishment of the "Credit Agricole d'Egypte",in 1931, and this was the period of real estate credit.The second stage, the period of the "Credit Agricole d'Egypte", extends from the year 1931 up to the promulgation of the Agrarian Reform Law in 1952. From the year 1952 up to the present time the third stage of cooperative organization has been prevalent.It should however, be remarked that, with the overlapping of these stages, their chronological limits are somewhat arbitrary.

Agricultural Loans of Real Estate Banks

The role of real estate banks in financing agriculture.

14. In view of the exceptional role of real estate credit in the agricultural credit history of Egypt, and the substantial change occured over it, in financing agriculture; it deserves mention in this paper. The "Credit Foncier Egyptien" was, and still is, the biggest real estate bank in Egypt, with its advances representing an important share of total real estate credit.Table I shows, during the period from 1914 to 1960, total real estate loans in Egypt, total loans advanced by real estate banks and loans advanced by the "Credit Foncier Egyptien".

TABLE I (£ Million)

Years	Total real estate loans	Loans advanced by real estate banks including "Credit Foncier Egyptien"		Loans advanced by "Credit Foncier Egyptien"		Loans advanced by other sources.	
		Amount	%of total loans	Amount	%of total loans	Amount	%of total loans
1914	46	39	85	31	67	7	15
1922	32	26	81	21	65	6	19
1929	29	25	86	20	69	4	14
1943	18	14	78	11	61	4	22
1954	17	12	70	10	59	5	30
1958	23	19	83	12	52	4	17
1960	24	20	84	13	54	4	16

The amount given in the Table I, in order to show total real estate credits advanced by banks, largely represent - up to 1943 - agricultural loans only.

15. In illustration of the importance of credit advanced by real banks to agriculture and of its decrease, especially since the second world-war, Table II is given to show the balances of

real estate credit granted by the "Credit Foncier Egyptien" as well as new credit advanced during the period from 1914 to 1958. Against these figures the value of the cotton crop is set for comparison.

TABLE II (£ Million)

Year	Balances of Agricultural real estate credit by the end of year.	New Loans during the year	Value of cotton crop
1914	22.5	2.7	15
1922	16.5	1.5	41
1929	15.0	2.1	34
1943	9.5	-	22
1954	3.8	0.2	97
1958	3.1	0.1	134

Short- term credit

Before the "Credit Agricole d'Egypte"

Role of the Government in the establishment of "agricultural credit bank"

16. Long-term credit institutions, which require the lodging of a mortgage, do not solve the financing problems of the small farmer. Nor do they satisfy the short-term credit requirements of the big landowner. The government endeavoured late in the nineteenth century to meet these requirements and, at the same time, to put an end to the unscrupulous money-lenders.The attempt was, however, limited. The "Agricultural Bank of Egypt " was set up in 1902 under the auspices of the government and the National Bank of Egypt. To protect the small farmer against money-lenders, the "five-feddan (1) law was promulgated in 1913, prohibiting the seizure of properties not exceeding five feddans, in settlement of debts contracted after the enactment of the law. But as a result of this law the bank's operations were almost paralysed.

Le "Credit Agricole et Cooperatif"(2)

17. The "Credit Agricole et Cooperatif" was set up in July 1931, to meet the urgent need of agriculture for a financing organization, after the liquidation of the "Agricultural Bank" and after it proved impracticable for the government to handle the extention of financial aid to farmers, either directly or through ordinary credit institutions. The Bank took the form of a semi-public institution, with a capital of £. 1m., half of which was subscribed by the Government, the rest being taken up by banks and financial institutions. A 5% annual return is guaranteed by the Government. In 1948, the Bank's capital was increased by £.0.5 m., half of which was provided by the Government and the rest by cooperative societies. In 1961, the Bank was nationalised.

(1) a feddan = 1,038 Acres

(2) The word "Bank" will be used for "Credit Agricole & Cooperatif"

Types of loans advanced by the bank.

18. There are three different categories:
(a) Short term credit, for periods not exceeding 14 months. It includes:
Cash loans, to meet cost of planting and harvesting;
Loans guaranteed by agricultural crop, and same of seeds and fertilizers against future payments.
(b) Loans for periods not exceeding 10 years, against mortgage guarantee, to purchase agricultural machinery and livestock or for land reclamation
(c) Loans for periods not exceeding twenty years, for the exploitation and reclamation of land, with a mortgage guarantee.
-Regarding the rate of interest it settled at 5% for individuals and 3% for cooperative societies.
In 1960 it was decided that the Bank's loans bear no interest.

Growth of activities.

19. Total Bank loans developed from £2m. in 1931/32, to about £37m. in 1960, mostly in short-term credit, whether in cash or otherwise. Table annexed illustrates this fact. It should be noted that, though no restriction was imposed upon the loans granted to cooperative societies, since the conversion of the Bank into a Bank for all cooperative (agricultural or otherwise) in 1948; such loans are still in the nature of agricultural short-term credit. Only limited changes took place in the last few years.

Trade Activities:

20. The Bank takes delivery of crops and supply goods (wheat and rice), either by buying it at a fixed price or by importing such or other goods (flour and jute); and carries out their distribution with other goods (sugar, oil and barley).

Financing of the Bank's activity:

21. Apart from its capital, reserves and provisions, the Bank obtained from the government, since its establishment, a permanent loan of £,6m. The government procures financing for supply operations. The Bank retained and used for its operation the unutilized part of these supply credits. The sums retained by the Bank amounted to more than £12m. on June 1950. In 1956 the Bank was authorized to issue long term bonds (20/30 years) within the limit of 20 millions, at an annual interest rate of 3%. The National Bank of Egypt (Central Bank) subscribed to the total of these bonds; but the proceeds were used in repaying the bulk of the Bank's debit to the government. In 1961 the amount of long term bonds subscribed by the Central Bank, was raised to £30, millions. This does not include credits to finance supply operations, which amounted to £16.8 millions by the end of 1960. The Bank also borrows from the Central Bank against goods and securities. In 1961, bills for three years and in the amount of £20, millions were issued by the Bank and subscribed by the Commercial Banks. These bills are discountable with the central Bank. The Bank is allowed to accept deposits from cooperative societies. The end-of-year

balance in 1960 amounted to £3.7m.

22. The following condensed balance sheet shows the activities of the Bank and its financing.

Condensed Balance Sheet

At December 31, 1960.

Assets:	
Cash at Banks	£. 4.180.763
Investments in securities	2.110.054
Loans to Cooperative Societies & Individuals	19.137.285
Stocks of fertilizers, jute bags, pest control chemicals etc. in stores and in transit.	11.273.824
Purchase of agricultural produce for Government account.	22.034.332
Sundry accounts	6.804.452
	£.65.540.710
Liabilities:	
Capital: 375000 Ordinary shares of £4. each fully paid	£. 1.500.000
Statutory reserve	337.649
Reserves and provisions	2.425.384
Loans and borrowings	38.947.108
Egyptian Government: supply accounts	7.303.979
Cooperative Societies:current accounts	3.700.577
Provision for staff and workmen's indemnities	2.559.617
Sundry creditor accounts	8.671.666
Net profit for year 1960	94.730
	£.65.540.710

The system of cooperative credit:

23. Though the Bank was originally designed to offer its services to small landowners and to cooperative societies, in practice big landowners profited from it up to 1952.Tenants could not borrow from the Bank, except through cooperative societies, which did not operate in a satisfactory manner until 1956, when "the cooperative credit system" was adopted. This system is concomitant with the carrying out of the Agrarian Reform, and the establishment of the cooperative Agrarian Reform Societies, which are state-organized societies and of the multifarious purpose type. According to the "cooperative credit system" not only loans and other credit facilities are delivered to landowners and tenants through the cooperative, but also the system of supervised credit is applied. Availability of credit is accompanied by the exertion of efforts to improve the agricultural production and the rural standard of living. The Credit Agricole et Cooperatif, through its technical staff has to supervise the use of loans and to offer its advice.

PART III

Concluding Remarks:

24. Economic, social and political considerations, make it

essential, for developing countries, to maintain a high rate of growth for agriculture. Many factors require that optimal means of agricultural finance be given increased attention and organization. In fact, economic, social and legal changes, which accompany the planned industrial development, lead to contraction in the mechanism, which was financing agriculture, before embarking on the process of development. As a result, the state assumes an important responsability, in providing funds for financing agriculture, either by direct investment or by credit expansion.

25. The need for agricultural credit may be small, as long as direct financing is an efficient substitute. It should be noted, however, that, with the system of private property as the foundation for the social and economic organization of agriculture, direct finance cannot completely replace credit.

26. The mobilization of resources for agricultural credit remain, therefore, one of the most important tasks of the government. The cooperative system can be used however in the distribution of agricultural credit.

27. The following points can be of use for developing countries:

a) Before attempting to organize the machinery of agricultural credit, it is necessary to survey existing needs and resources. This survey must include resources of money-lenders and merchants, who usually procure an important part of agricultural credit.

b) No waste of resources should be involved in the process of distribution, whether within cooperative societies or the financing institution. The waste can take place on account of utilizing resources, where they are not most productive. Thus, it should be assured that loans are utilized in conformity with the purposes for which they were originally granted. Loans should also be repaid on their due date, so that funds allocated for agricultural credit may continue to be in the nature of a revolving fund.

c) Moreover, waste is frequently generated by the common and erroneous belief, that profit criterion is not applicable in the field of agricultural cooperative credit. Such a criterion should, neverthless, be adhered to. Public or cooperative enterprises, which produce for the market and can measure the success of their activities in terms of monetary profit (surplus) have to be judged by market criteria.

28. If for special considerations, interest on loans provided by the "Crédit Agricole et Coopératif" was cancelled, this does not mean that there is no criteria, by which the success of the Bank can be assessed. Such assessment is still possible, perhaps by means of an accounting profit measure, whereby interest is recorded without being collected (1).

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(1) Total interest due over loans advanced by the "Crédit Agricole in the financial year 1960, are estimated for about £ lm.

ANNEX

(Table III) CREDIT FACILITIES GRANTED BY THE "CREDIT AGRICOLE ET COOPERATIF
1953 - 1960

(In £.1000)

YEARS / CATEGORIES OF CREDIT	1953	1954	1955	1956	1957	1958	1959	1960
SHORT-TERM CREDIT								
Individuals	12.561	12.890	13.526	10.965	11.934	12.190	8.806	5.682
Cooperative Societies	3.452	3.973	4.705	5.295	6.392	9.577	16.730	25.880
Cooperative credit for different purposes.	264	451	1.014	(1)1.250	(3)1.742	(4)2.501	3.271	3.581
	16.277	17.314	19.245	17.510	20.068	24.268	28.807	35.143
MEDIUM-TERM CREDIT								
Individuals .	12	9	11	-	10	5	9	94
Cooperative Societies	84	114	153	(2) 220	127	201	575	1.220
Cooperative credit for different purposes.	-	-	51	-	-	-	5	183
	96	123	215	220	137	206	589	1.497
LONG-TERM CREDIT								
Cooperative credit for different purposes.	12	11	13	-	-	-	17	32
T O T A L	16.385	17.448	19.473	17.730	20.205	24.474	29.413	36.672

(1), (3), (4) Including some medium and long term credit "for different purposes"

(2) Including a small proposition of credit granted to individuals for land reclamation.

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UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

SUMMARY

Agenda Item: C.1.2

United Arab Republic

AGRICULTURAL CREDIT AND COOPERATIVE ORGANIZATION

By A. EL TANAMLI, Ph.D.,
President of the
"Credit Foncier Egyptien"

Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

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AGRICULTURAL CREDIT AND COOPERATIVE ORGANIZATION

by
A. El Tanamli, Ph.D., President of the "Credit Foncier Egyptien".

Part I
GENERAL TRENDS

Supply of agricultural credit: Mobilization of funds depends on the ability of the national economy to collect and direct savings to meet consumption and production requirements of the farmers. Obstacles emanating from the nature of agricultural production and from the changing position of the agricultural sector hinder the supply of credit.

Distribution of agricultural credit, is sometimes carried on by the private enterprise, including banks, insurance companies, money lenders, merchants and intermediaries. Cooperative machinery plays an important role. The gap is usually filled in by the state, either through the cooperative organization or by establishing specialized agencies.

Case of under-developed countries: Savings in under-developed countries are inadequate. The necessity for organizing agricultural credit is accentuated by the lack of an organized credit and financial markets. Expatriate banks stand aloof from agricultural finance.

Industrial development draws funds from the agricultural sector especially when such development is handled by the public enterprise.

Social change in developing countries creates new credit problems. Private Banks demand types of collateral not within the reach of the small-scale farmers.

It seems incumbent on the state to face the problem of agricultural credit, short and long term.

The role of cooperative societies: Cooperative Societies were sometimes established in developed countries when the market failed to procure credit at an appropriate cost. Such pattern of classical cooperation does not suceed in under-developed countries. General trends are for compulsory and state-financed cooperation.

PART II

THE U.A.R. PATTERN

Agricultural loans of Real Estate Banks: Important long term financing by Real Estate Banks dwindled since the thirties and almost disappeared since World War II.

Short-term credit before the establishment of the "Crédit Agricole d'Egypte": The Government endeavoured since the 19th century to procure short-term credit to agriculture.

The "Agricultural Bank of Egypt" was set up in 1902 under the auspices of the Government and the "National Bank of Egypt". But the five feddan law of 1913, prohibiting the seizure of properties not exceeding five feddans, paralysed the Agricultural Bank's operations.

" Crédit Agricole et Coopératif" (1): The "Crédit Agricole d'Egypte" was established

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(1) The word "Bank" will be used for the "Crédit Agricole et Coopératif".

in July 1931. Government subscription amounted to half of its initial capital. A 5% annual return was guaranteed. When capital was increased in 1948 and the "Bank" was converted into a Bank for cooperatives, it was called upon cooperative societies to subscribe half of this increase. In 1961 the Bank was nationalized.

Types of loans:

a) Short term credit, for periods not exceeding 14 months. It includes: cash loans to meet cost of planting and harvesting, loans guaranteed by agricultural crops and sale of seeds and fertilizers against future payments.

b) Loans for periods not exceeding 10 years, against mortgage guarantee, to purchase agricultural machinery and livestock or for land reclamation.

c) Loans for periods not exceeding twenty years, against mortgage guarantee, for the exploitation and reclamation of land.

The rate of interest was 5% for individuals and 3% for cooperatives. In 1960 it was decided that the Bank's loans bear no interests.

Growth of activities: Total Bank credit increased from £2 m. in 1931/32, to about £37 m. in 1960, mostly in short term credit.

The Bank takes delivery, imports and carries out the distribution of supply goods. Central Bank credits guaranteed by the government for these purposes amounted to £16.8 m. by the end of 1960.

Financing of the Bank: Apart from its capital, reserves and provisions (£4.3 m. end 1960), the Bank had at its disposal, up to 1956, a permanent governmental loan of £6 m. In addition, it retains and uses, funds put at its disposal by the Government for supply operations (£6.7 m. end 1960).

In 1956, the Bank was authorized to issue long term bonds (20/30 years) within the limit of £20 m. (raised to £30 m. in 1961) at an annual interest rate of 3%. The National Bank of Egypt (Central Bank) subscribes to the total of these bonds. Borrowing from the Central Bank against goods and securities amounted to £2.1 m. by the end of 1960. In 1961 bills for three years (£20 m.) discountable with the Central Bank were issued by the Bank and subscribed by the Commercial Banks.

The Bank accepts deposits from cooperatives (£3.7 m. end 1960).

The system of cooperative credit: The Bank was established to offer credit to small landowners and to cooperatives. It was not until 1956, when the cooperative credit system was adopted, that tenants could make use of these facilities. Accordingly, not only credit is granted through cooperatives, but also the system of supervised credit is applied.

PART III
CONCLUDING REMARKS

The following points can be of use for developing countries: (a) A comprehensive survey covering credit needs, facilities and existing resources, including those of money-lenders and merchants, is essential to reorganize agricultural credit.

(b) Since resources of cooperatives are very limited, free classical cooperation seems to be inadequate. New formulas, therefore are to be worked out.

(c) Strict measures are necessary to avoid waste of resources in the processing of agricultural credit. Supervision of credit granted is necessary to secure its proper usage and repayment as designated.

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Agenda Item: C.5.2

United States of America

ANIMAL IMPROVEMENT AND ADAPTATION

By Jay L. LUSH,
Iowa State University,
Iowa City, Iowa,

Jorge de ALBA,
Instituto Interamericano de Ciencias
Agricolas de la OEA,
Turrialba, Costa Rica

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ANIMAL IMPROVEMENT AND ADPTATION

By
Jay L. Lush, Iowa State University, Iowa City, Iowa
Jorge de Alba, Instituto Interamericano de Ciencias
Agricolas de la OEA, Turrialba, Costa Rica

What is Ideal?

1. The first step in an animal improvement program is to define what kind of animal is "best" for the purposes of the people in the country concerned. That means considering not only the human needs for the products of these animals, but also the qualities of the animal itself which will promote its own well-being. Even religious or other cultural values may bear importantly on whether surplus animals or those of little merit can be killed and whether animals have values as symbols of their owner's social status or wealth. Usually only a local person or at least one who has lived in the country for several decades can know the culture of the people well enough to realize the true value of livestock in that society, but this may seriously modify the objectives of an improvement program. Human needs concern such things as milk, meat and eggs for human food; work; wool, hides; etc. The animal's well-being can depend to some extent on such things as its tolerance to heat, cold or rain; its ability to withstand inadequate nutrition during certain seasons; its resistance to diseases and to insect pests; etc.

Individual Merit

2. Measurement or appraisal of an animal's merit merely expresses how closely that animal conforms to the ideal. Merit may be defined either phenotypically or genetically. The former involves only the animal's own observed qualities. The latter concerns the kinds of offspring and other descendants the animal is likely to have. An animal's genetic merit can be estimated only indirectly by considering its own phenotypic merit and also the phenotypic merits of its available relatives. In considering all of these phenotypes the effects of variations in the environment should be discounted as much as possible.

3. The simplest definition of individual merit may be merely a verbal description. A score card is a somewhat more quantified description. A selection index is a score card modified still further by such knowledge as we have of heritability and genetic and phenotypic correlations among the constituent qualities. The selection index is intended to rank the animals according to their value for breeding purposes (i.e. according to their genetic merit); whereas the ordinary score card ranks them only phenotypically according to their own appeaance or performance.

4. The individual merit that concerns the modern breeder is in productivity, rather than in bodily form. The measurements of productivity should be as direct as possible, such as: Weights of fleece or of milk produced; weights of young reared to weaning; growth rates in general; longevity; life-time production; etc. Although such measures do not show an animal's real and complete productivity with perfect accuracy, they are so much more accurate than easily observable external "sign characters", such as color, shape or size of horns, shape of head, size of skeletal frame, conformation of legs, etc., that the latter have only faint utility. The wide popularity of "sign characters" is due mostly to human nature and to the ease of observing such "signs".

5. Practical merit involves many characters, several of them important, but the whole animal is the smallest unit which can be selected or rejected. Therefore, one simply must add (or combine in some other way) an animal's high merit in one quality, medium merit in another, and low merit or defectiveness in others, to decide whether to keep or cull the animal. This combination we call "net merit", realizing, of course, that in some cases net merit can be for breeding. The measurement of merit must be kept simple for practical reasons but it is complicated by the fact that many qualities enter into it, some of which are of minor importance. The following procedure seems to work best: Measure as directly and simply as possible the 2, 3 or 5 most important aspects of productivity and allot to them about 60 to 80 points. Then group together all the remaining characters which contribute enough to merit to be worth considering, calling this group by some such term as "general appearance" or "other qualities". Allot to this group the remaining 40 to 20 points on the score card. More detail and refinement of records and their use will be worth while, only if it increases the accuracy of choices enough to be worth more than the costs of the extra work. However, this is not likely to be feasible in the first programs in the less developed countries, but that is a matter for local decisions and ingenuity.

6. What one will actually do at a given moment, on the basis of these ratings of merit, is simple. Either he culls the animal or keeps it for breeding purposes. If he keeps it, he may also need to decide whether he will keep its sons as well as its daughters, or will keep only its daughters. For the animals which are retained now, decisions may need to be made again next year when new information has become available.

Improvement by Breeding

7. The basic principle is that the animals which are closest to the ideal in their genetic merit should be used most extensively for breeding, while those furthest from the ideal should be culled at the earliest opportunity. Performance testing is done to measure phenotypic merit. Progeny testing, as well as information on parents and collateral relatives, come into the picture only as they help to correct some of the mistakes which would be made if decisions about each animal were made entirely on its own phenotypic merit. Artificial insemination comes into the picture only as it permits more intense selection among the males thought to be best. It does not change at all the kinds of genes the chosen sires transmit. Also it can make importation less expensive by getting more offspring per imported sire. With artificial insemination, therefore, the importance of deciding correctly which males are really best for breeding use is increased, since fewer males are used and any mistakes made in choosing one of them will affect more individuals in the next generation.

8. Improvement in animal breeding can follow two different roads. These have some things in common but are mutually exclusive in others.

9. The first road, the traditional one, is to select the best and cull the worst in the hope of improving the whole stock more or less steadily. The ultimate goal is to produce a stock which is fully as perfect as any cross which could be made from it. In genetic terms, this is hoping to make a stock homozygous for all the "good" genes and free from all hereditary defects. To this end, attention to ancestors, collateral relatives and progeny, are mere devices for making selection more accurate and therefore hastening progress. In traveling this road, line-breeding is used as a holding action, whenever an unusually good animal appears, and also to harvest some of the epistatic effects by bring together repeatedly in favorable combinations genes, which in other combinations are unfavorable. Otherwise all forms of inbreeding are avoided. If this road really is traversible, it is the simpler of the two.

10. The second road leads toward a situation in which seedstocks are bred separately from each other but are outcrossed, in one way or another, to produce animals for use. This can be called breeding for heterosis. This road may be the best one when, in many pairs of genes, the heterozygote is individually preferable to both homozygotes. This may happen for a variety of genetic reasons, which will be mentioned briefly later. Since the seedstock animals are to be crossed on those from a different seedstock, the practical test of the individual breeding merit is the average merit of the crossbred progeny they produce with that other stock. This road relies more on the progeny test and much less on individual merit of the animals in the seedstock than does the other road. The important thing is that the progeny by which an animal's breeding value is judged shall be out of crosses with the same kind of stock as that on which it is expected to be used when producing animals for use. The pure seedstock is to be improved not in its own individual merit, but in its ability to produce good crosses.

11. This second road, if ultimately successful, would lead to pure seedstocks which are only mediocre or less in individual merit but cross with each other to produce individuals which average better than any purebred population which could possibly be produced by travelling the other road. This second road is currently being used in the United States in producing hybrid maize and in practically all of the poultry breeding. The methods of forming the various seedstocks may be simple intense inbreeding, which is the usual one in maize, or more complicated systems, such as "reciprocal recurrent selection", may be used.

12. Crossbreeding is a way to travel this second road, a method already widely practiced with some farm animals in some parts of the world. Instead of starting by making new seedstocks especially well adapted to crossing with each other, one merely finds which of the already existing breeds, or other genetically separate stocks, cross well with each other and then proceeds to use those at once. Formerly it was usually recommended that all of the crossbreds, both males and females, be sold and none of them be saved for breeding. The generally succesful work on "crisscrossing" at the Minnesota Station and elsewhere which began to be published in the 1930's cast doubt on this recommendation. The experiments with 3-breed and 4-breed rotation crossbreeding, which began late in the 1920's have tended to confirm the conclusion that the replacement females can come profitably from the crossbred stock. This also agrees with the extensive experiments of the maize breeders and, as far as they go, with the experiences of the poultry breeders.

13. All that remains important is that the males shall be purebreds from breeds which cross well with the breeds from which the sire (and preferably also the maternal grandsire) of the females come. Even crossbred sires may be used, provided both are breeds which were crossed to produce the sires and maternal grandsires of the females on which these crossbred sires are to be used. Naturally, this last condition is rarely met. The use of an actually crossbred sire is still generally regarded with disfavor by animal breeders, although it is standard practice in the breeding of maize and of some chickens, particularly among the egg-producing crosses.

14. Such crisscrossing or rotation crossbreeding could begin at once in the less well-developed countries if one or more breeds can be found and imported which cross well with each other and with the native stock. The native stock are likely to furnish some useful local adaptability. In a crisscrossing system in which the natives constitute one of the stocks, the percentage of native blood will vary from 33 to 67 after the system gets well under way. In a regular 3-breed rotation, it would vary from 1/7 to 4/7. The producer need not buy females. It is important, however, that someone in the country continue to breed enough pure native stock to furnish the native sires needed at one step in the rotation.

15. Trying to travel this second road without using the existing stocks or breeds at the very beginning would be unwise for any of the less well developed countries. Making new and relatively pure lines would be expensive and would require several generations, whether they were made by inbreeding or by selecting on progeny tests for cross-combining ability. Much expensive and detailed progeny testing and other record keeping would be necessary. This may not be feasible in such lands, and waiting so many years to harvest the increased productivity may be impossible. Even in the countries where animal breeding is highly developed, it is not certain that making seedstocks expressly for their increased cross-combining ability will ever be feasible for types of animals that are less prolific and which have longer generation intervals than swine. Even with swine the practicality of this road is still in doubt.

16. Crosses often have higher average individual merit than either parent race. This is generally called "heterosis". It is rather frequent but it does not occur for all characters nor in all crosses. To gain the benefits of heterosis is the chief reason for using breeding plans which are more complicated than simply finding and breeding the best individuals, while culling the worst as opportunity offers. To see how the gain from breeding for heterosis might be large, consider a case of simple over-dominance where AA averages 100 on the scale of merit; Aa averages 110; and aa averages 70. If these contribute offspring to the next generation in proportion to their own merit, the population will reach a ceiling where it consists of .64 AA: 32 Aa: .04 aa and its average merit is 102. Selection cannot increase its average merit further, so long as the individuals interbreed freely. To select more intensely for the Aa's would lower average merit by making the aa's more frequent, while selecting more intensely for the AA's would lower merit by making the Aa's rarer. The constant presence of 4 percent of definitely inferior aa individuals in the population is the price paid for raising the average merit of the population to 102, instead of leaving it at 100 where it would be if the population were homozygous for the "best" gene; i.e. were pure AA. If, on the other hand, one could make and keep two separate pure seedstocks, one aa and the other AA, and could cross these to produce the animals for use, this crossbred population would average 110 in merit. The cost of securing this gain from 102 to 110 would be the costs of making and maintaing the two pure seedstocks which, in their own merit, would average only 700 and 100, respectively.

17. Heterosis in net merit can occur even where the cross does not exceed the better of the two parent races in any character. All that is necessary is for the one parent race to be superior in some respects and the other in other respects, while the cross tends to be nearer the better parent in each case. This is illustrated schematically by the following figures where equal weight is given each character.

	Race		
	A	Cross	B
Merit in character No. 1	100	98	80
" " " " 2	90	96	100
Average Merit	95	97	90

18. This is a rather common situation in crossbreeding. Usually a breed will be chosen for a cross only if it has some characteristics in which it excels and, since it is not perfect, it will fall behind the other breed in some other qualities. If several characters are involved and if the cross is nearer to the better parent in each, the cross is likely to excel both parents in net merit, even though it may not excel the better parent in any one character considered singly.

19. Several genetically different mechanisms or situations can cause heterosis. They include such diverse things as:

a. Each parent race having some of the desired characters which the other lacks (discussed above).

b. Simple overdominance in one or more pairs of genes (the order of merit is Aa-AA-aa).

c. Year-to-year or place-to-place variations in the environment, whereby sometimes one and sometimes the other parent has the higher merit. This is partly the same as (a).

d. The heterozygote is better buffered against the environmental changes than the homozygotes are. This is partly the same as (c).

e. The population is not entirely at linkage equilibrium.

f. Pleiotropy whereby each gene has several effects, some good and some bad. This may be the main cause of (b).

g. Some of the desired characters may be partially antagonistic to each other genetically. This partly overlaps (a) and (f).

h. Epistatic effects in general. (The simplest case is where two non-allelic genes together produce desirable effects although their average separate efforts are undesirable.)

All of these causes of heterosis require some dominance. Most of the immediate and observable consequences are the same as if the heterosis were all caused by (b), although the results can become different in later generations, especially if (a), (e), or (h), cause much of the heterosis.

20. The amount of heterosis expected in the first cross between two stocks which have each been breeding within themselves depends mainly on the degree of dominance and the genetic diversity of the two stocks. Each pair of genes contributes to the heterosis $(k-1)\ (q_1 - q_2)^2x$; where k is the degree of dominance on a scale from 1 for no dominance, through 2 for complete dominance, to more than 2 for overdominance; q_1 and q_2 are the respective frequencies of that gene in the parent stocks; and $2x$ is the average difference between the phenotypes of aa and AA. Half of this is permanent; the rest disappears at once and entirely from the offspring when first crosses are mated together, -- somewhat more than half of it disappears if 19 (h) is a major cause of heterosis. A little of the half of heterosis which is temporary can be retained by continuing to outbreed, as by backcrossing, crisscrossing, mating those from the most unrelated families, etc. The $(q_1 - q_2)^2$ term, which measures the genetic diversity, indicates roughly how much can be retained thus.

21. In a system of rotation crossbreeding where the females are always mated to males with a percentage of blood as different from theirs as is available, the percentage of heterozygotes remains higher than it would in a pure breed made from any of those crosses. This is the basic genetic reason for using a rotation crossbreeding system wherever the heterosis is large and the economics of the case and the kinds of animals available will permit.

22. The following actual data from the Inter-American Agricultural Institute in Costa Rica illustrate marked heterosis in daily gains and practically no heterosis in muscle area.

Breed or Cross	Daily gain (grams) (corrected for sex)	Muscle area ($cm.^2$) (males only)
Brahman (Zebu)	602	64
Criollo	495	80
Criollo X Brahman	622	78
Brahman X Criollo	691	70

In daily gain the two crosses exceed the average of their parental races by 73 and 142 grams, respectively. In muscle area the two crosses differ little, either from each other or from the average of the parental races.

Deception by Heterosis

23. When the first cross offspring of imported males and x native females seem definitely superior to the native stock, it would be only human to credit all of this improvement to the imported sires, especially if purebreds of the imported race are not available for comparison. This, however, may not be valid. The crosses may also be superior to what the pure imported stock would be if grown under the same conditions.

24. In the example of cattle gains in Costa Rica, if we had data only on the Criollos and on the cross of Brahman bull and Criollo cow, we might infer that the Brahmans were vastly better genetically than the Criollos. If, however, data were available only on the pure Brahmans and on the cross of Criollo bull and Brahman cow, it would have been inferred that the Criollo was better than the Brahman. With data from all four of these combinations we conclude correctly that the Brahmans do gain somewhat more rapidly than the Criollos, but that the crossbreeding effect itself is tremendously larger than this difference. This is a measure of what is called "heterosis". By contrast, in muscle area, the Criollos have definitely larger muscles than the Brahmans and the heterosis seems small.

25. If we know only one pure breed and one pure cross, we can be vastly misled in inferring the merit of the other pure breed. For example, if we know the rate of gain only for the Criollos and for the cross of Brahman bull on Criollo cows, we might infer that the favorable results were due to the general merit of the Brahman breed. Then we might think that the rate of gain of the pure Brahman would be 887 (i.e. 691 + (691 - 495), plus or minus whatever allowance we thought proper for the data being few! We would estimate that if we made a second cross to the Brahman the 3/4 Brahmans would average 797 (i.e. (691 - 495)/2) whereas, if we know the data for all 4 kinds of breeding and allow for loss of heterosis, we will expect only 629 (i.e. half of (691 + 622)/2 + 602) for the 3/4 Brahmans.

26. As another example in which, however, only one of the reciprocal crosses is present, consider the following data from the same station for average 4% fat-corrected milk production of stablemates in kilograms during each of the first four months of the first lactations.

	Month			
Breed or Cross	1st	2d	3d	4th
Criollo	266	230	224	189
Jersey	237	226	202	178
Criollo X Jersey	273	248	245	254

Heterosis is nearly 9 percent in the first two months, 15 percent in the third and 38 percent in the fourth. This is the evidence on the amount of heterosis in this character in this cross, although one may wonder whether reciprocal crosses would show any differences, such as might be caused by sex-linkage or by maternal effects.

27. Heterosis should be estimated early in the process of planning to improve the native stock by using sires imported from some supposedly superior breed. The amount of heterosis might alter decisions on such important matters as whether: 1) to continue grading the native stock to an imported breed, 2) follow a plan of rotation crossing, or 3) try to make a new breed, moderately stabilized at some fraction of imported and native blood. The larger the heterosis, the more important a practical plan for 2) becomes.

Importing

28. As soon as one has decided what kind of stock would really be ideal for his purposes, he seeks the breeding stock which is already nearest that ideal. The native stock should be considered first, as it is the most available, almost always the cheapest, and usually already has considerably more adaptability to local conditions than any stock which could be imported. Although well adapted to survival under the local conditions, they are likely to be slow maturing, thinly muscled, and not likely to produce large quantities of milk or wool, or other of the products which a developing country needs. However, before deciding that the native stock is not suitable, it may pay well to visit all of the possible places where such native stock has been improved by the better local breeders. Some of these local efforts may show definitely that the local stock contains many advantageous qualities which are hidden now but which will come to light when the animals are given better care and are selected for more production. One cannot thus estimate the ultimate to which the stock might be improved, but, if even a few breeders have already made obvious improvement, it is likely that those

limits are still far off. At least, one may infer that the local stock has enough obvious or hidden merit that it should not be replaced entirely but should be retained as one of the stocks to be used in a rotational crossbreeding program or as part of a foundation from which a new breed is to be made.

29. Improvement by breeding is a slow process. Hence, it might be quicker to import an already improved stock if a productive one can be found which is adaptable to the local husbandry. Whether such stock exists is difficult to determine. The excellence of an improved stock in its native land may be due largely to the good nutrition and other excellent environment given it there. One of our colleagues active in extension work in dairy cattle breeding in the U.S. has often said: "No bull was ever good enough to transmit to his daughters good pastures and leafy green alfalfa hay"! How the imported breed will perform in the importing country can be learned only by trying it there. This, however, is costly in time and money. Some of that often can be saved by visiting other countries, somewhat similar in climate and other environmental conditions, to see how any breeds they have imported have actually thrived. Verbal testimony about performance may need discounting, since at least a few enthusiasts about almost any breed can usually be found.

30. An imported breed is rarely suited perfectly to the local needs. Occasionally a breed may fit the local needs well enough that the wisest course is to import that breed and use the males to grade the local stock continuously toward that breed. In such a case, importing also a few females might be wise for two reasons. First would be to learn how well the females of that pure breed perform under local conditions. If the native stock is graded continually toward this imported breed, the resulting high grades will eventually be much like the imported purebred females genetically. If the purebred females are ill-adapted to the environment in any important aspects of their performance, that should be discovered before the grading goes far. Secondly, the sons of the imported females could be used for continuing the grading process. This would reduce the amount of importation necessary for replacing the initial purebred males. Using sons and grandsons from such a nucleus herd need not lead inevitably to high inbreeding. As long as the breed continues to exist in its native land an occasional importation, perhaps at considerable expense, of fresh stock to be used on the nucleus herd would cancel at once the inbreeding accumulated up to that time.

31. The native stock should be very nearly equivalent to the imported stock by the time it has been graded up to contain 7/8 or more of the imported blood, unless improvement in the native land of the breed continues much more rapidly than in the importing land. In such a case, which is rather unlikely but not utterly impossible, continuing indefinitely into the future to import a few animals from the original home of the breed at frequent intervals may be advisable.

32. More frequently, it will be found that no breed exists which is already this well adapted. Each of many breeds which might be imported may be desirable in some characteristics such as ability to produce milk, wool or meat when properly fed; and very undesirable in others, such as adaptability to extreme heat or cold, or susceptibility to parasites or diseases, or to other environmental influences different from those in their native land. Desirable characteristics tend to be partially dominant. Some heterosis often occurs when strains very unlike in their racial origins are crossed. Hence, the first crosses of imported stock on the native stock often appear more desirable than the natives and also more desirable than the pure imported stock would be. Continuing to grade toward the imported stock, generation after generation, will then cause a decline in average merit, partly because the animals are losing the adaptability of the natives and partly because they are losing heterosis.

33. Two quite divergent roads to meet this situation are imaginable. One is to try to make a new breed out of the first crosses, or perhaps out of a mixture of first crosses and back crosses, hoping to form a new breed which will be more than half-way toward the qualities of the better breed in each respect. The other road is to adopt and continue some form of rotation crossing, first, toward the one parent stock and then toward the other. This requires maintaining both of the parent stocks in a usably pure condition. If successful it maintains more heterosis than if all of these animals were mated at random.

Making New Breeds from Crosses

34. When no existing breed comes close to the ideal but each of two or more have some different desirable characters and some of these crosses are known to be promising and heterosis seems not to be large when each character is considered by itself, trying to blend them into a single new breed may sometimes be wise, although this will require so much time that its advisability in a less well developed country may be questioned.

35. The first step is to decide what crosses one should make and in what proportions. Naturally, one would want to use enough breeds to introduce all of the qualities he thinks he will need eventually. Of course, also he would want to use a larger fraction of blood from the races which had several desirable traits and were nearer to his ideal than from races which had only one or two desirable characters which the other races lacked. At least two generations are required to bring together the inheritance from three to four different races. At least three generations are necessary if five or more are to be brought together.

36. The second step is to discount the effects of heterosis. Unless one does this, he will be unduly disappointed in the generation when all the temporary heterosis first disappears. That will be the first generation produced by mating together males and females which have the same percentage composition of blood. Then for the first time one sees the average phenotypic merit of the population with which he is really starting to make a new breed.

37. A third important part of the plan is to keep the genetic base broad. Neglecting this appears to have been the major cause of failure in most of the past attempts to form new breeds which were successful initially. To keep the genetic base broad, present knowledge of genetics suggests that every generation of animals saved for breeding should include the offspring of four or five widely used males. This might mean starting 10 or 12 males in service each generation or it might mean starting as few as 5 or 6, depending on how many of the males that were first tried were later culled on the basis of progeny tests, along with most of their offspring. This should keep the genetic base broad enough that no trouble would arise from this source, at least within the next 6 or 10 generations of animals.

38. Failure to keep the genetic base broad is most likely to arise through not using enough different sires in each generation. For instance, if only one sire is used, or if 4 are used but one of these does so much better that all 4 of the sires saved for the next generation are sons of this one, it will soon happen that any mating which can be made and still remain within the limits of the new breed will involve more inbreeding than is safe. Most of the bad consequences of such inbreeding, especially those from numerous genes with individually small and harmful effects, can then be repaired only by a wide outcross. Such a wide outcross would also undo most of the favorable progress already made.

39. When trying to make a new breed, the pedigrees should be planned roughly for the next two or three generations. That means choosing now the group of females from which are to come the males to be used in the next generation and choosing a somewhat larger group from among whose daughters are to come the sires to be used in the second and third generations. Mendelian segregation introduces enough chance and uncertainty that one is usually wasting time if he plans today the exact pedigree of an individual sire he intends to use 2 generations from now.

40. If the new breed is to be used commercially as nearly pure for its own qualities, rather than to be used in a rotation crossbreeding scheme, the new breed would be made as a single large population with only slight subdivision into families. Such subdivision would be for line breeding or progeny-testing purposes and with the intention of top-crossing the best families on all the rest of the stock as soon as the best ones are identified. If, on the contrary, this new breed is being made for use in a rotation crossbreeding plan, one would want to produce at least one other stock to be rotated with it in that crossbreeding and he would want to keep these two or more stocks genetically as unrelated to each other as possible.

41. Other practical considerations enter the problem, such as the fact that the females of the native race may be better grazers or otherwise better adapted to the local environment, so that the cross made one way may give better results than the reciprocal cross. Factors such as difference in mothering ability and the probability that the imported race and the native race were not equally far from the goal initially, make it sometimes advisable to choose a level of 1/4 imported blood, or of 3/4 imported blood, or some fraction other than 1/2 as the best percentage of blood around which to make a new breed or around which to oscillate in a crisscrossing plan. The question of what is ideal in this respect may well have different answers for differing breeds and different crosses in different countries. Being familiar with the country and with the actual average performance of different mixtures is of the utmost importance for making correct decisions on points like this.

Individual Adaptation

42. An animal taken from its native country to a land with a distinctly different climate may require many months to adjust its own individual physiology in the new environment. If the animal is mature when imported, it may never complete this adaptation. For example, beef bulls reared in the cornbelt in the U. S. until they are two years old and then taken to the harsher range country are mostly too old then to learn how to make a living on the open range. They would have learned that if they had spent their calfhood there. The reproductive cycle may be upset when animals are taken from the Northern to the Southern hemisphere or the reverse. Usually they adjust within a year or so. Similar upsets may occur when they are moved suddenly from a temperate climate to the tropics or from low to extremely high altitudes.

43. These practical and important facts are already moderately well known to stockmen and herdsmen who have made or accompanied importations of animals from one climate to a distinctly different one. This individual adaptation has little or no genetic implication, except insofar as ability to adapt is itself partly conditioned by the animal's genotype.

Fitting the Plans to the Country

44. Animal improvement schemes should be fitted to the present state of husbandry in the area under consideration, or to what seems likely to be the state of husbandry there in the near future. Because improvement by breeding comes slowly, one really should be breeding animals adapted to the conditions which will prevail at least two or three animal generations later, as far as he can estimate now what these conditions will be.

45. Conditions of husbandry may sometimes change rapidly. Resistance to disease and to insect damage may be highly important initially but they will become unimportant if and when cheap and effective methods of disease and insect control are put into use. Perhaps pastures and feed production may be improved so much that in a generation or two different qualities in the animals will be wanted, such as earlier maturity, and less value may be attached to their ability to survive well through periods of submaintenance nutrition. Perhaps such nutritional improvement will not come?

46. Such changes in husbandry or changes in market demand occur, even in the highly developed countries. Robert Bakewell's achievements in animal breeding two centuries ago consisted largely in breeding animals to be fatter at early ages than animals had ever been before. New edible fats of vegetable origin have become far more abundant than in Bakewell's time and pigs and even cattle are being bred with less fat and more lean.

47. Consequently the men who do or guide the animal improvement, need to know the local conditions well. A man from the outside cannot go in and guide the animal improvement schemes effectively. The plans for performance testing and progeny testing need to include provision for training local personnel to operate these plans, and especially to push the extension phases of the plans. These men need access to experiment stations where they can obtain answers to some of the simpler questions

and can measure the individual performance and adaptability of at least those animals in the nucleus breeding herds. First-hand familiarity with the reproductive rates, rearing percentages, and other vital statistics of the species in that region is almost a prerequisite for a man to help wisely in planning animal improvement.

48. Some of the devices for improving animals genetically require keeping individual pedigrees. Sometimes this is not possible. Fencing may be too expensive or other reasons may prevent knowing which male was the sire of each animal. If individual pedigrees are not known, no progeny testing of males is possible and the progeny testing of females is very limited. This will slow down the possible rate of improvement but does not stop it altogether. When the sires are unknown, most of the selection must be done on individual qualities. One can perhaps separate the males and females which seem to be the very best into a top stud flock from which will come the sires to be used in the next generation and keep that stud flock isolated. In this way, even without knowing the individual sires, one can get some (but not all) of the advantages of selection on pedigree.

49. If individual production cannot be measured, the possible rate of animal improvement is much reduced. Then one can only fall back on "eye-ball" judgment, which is reasonably good for some characters but notoriously ineffective for improving others, especially for those aspects of production which are complex and rest more largely on physiological than anatomical differences.

50. The main considerations for long-time progress are assurance of economic stability, reasonable expectation of law and order, and that the owner or local manager of the herd have incentive to use his own initiative and to take some risks. If the local manager is blamed when things turn out wrong but is not given a special reward when they turn out well, he will generally try to take as few risks as possible. If this condition is extreme, he may do little except execute written orders scrupulously, so as not to be blamed. This is more serious in animal breeding than in many other branches of human endeavor, because the actual outcome of animal breeding efforts, especially in herds of small or moderate size, is greatly affected by chance events. Mendelian segregation and recombination keep restoring and introducing individual variability in breeding values. With the finitely small number of sires chosen on any one farm, the man who does the choosing will often be wrong in individual cases, even though he works diligently and intelligently. Knowledge of genetics has reached the stage where one can predict with high accuracy the average result of choosing 1000 sires by method A rather than by method B, but he cannot yet, nor is there any prospect that he ever can predict closely the outcome for each such individual sire. Operationally, animal breeding is much like aiming a shotgun and not at all like aiming a rifle! This may not be entirely a disfavor; any sensible hunter would choose a shotgun for some kinds of game and a rifle for others!

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ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

C O R R I G E N D U M

Page 6, paragraph 25, line 8, change to read as follows :

"... average 789 (i.e., 691 + (691-495)/2) whereas, if..."

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C O R R I G E N D U M

Page 2, paragraph 5, line 5, should read:

"This combination we call "net merit," realizing,of course, that in some cases net merit can be higher or lower according to the kind of mates the animal would have if kept for breeding."

Page 3, paragraph 13, line 3, should read:

"Even crossbred sires may be used provided both breeds which were crossed to produce them are breeds which cross well with all the breeds from which came the sires and maternal grandsires of the females on which these crossbred sires are to be used."

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SUMMARY

Agenda Item: C.5.2

United States of America

ANIMAL IMPROVEMENT AND ADAPTATION

By Jay L. LUSH,
Iowa State University,
Iowa City, Iowa,

Jorge de ALBA,
Instituto Interamericano de Ciencias
Agricolas de la OEA,
Turrialba, Costa Rica

Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

NOTES

1. Papers selected for inclusion in General Sessions will be available at the Conference in the following official languages of the United Nations: English, French, Russian and Spanish.

2. Papers selected for inclusion in Specialized Sessions will be available at the Conference in only one of the above official languages.

3. Summaries of all papers, as submitted by contributors, will be available at the Conference in the following official languages of the United Nations: English, French, Russian and Spanish.

4. Papers and summaries will not be available for general distribution in advance of the Conference. They will be published in advance in limited quantities only for the use of delegations of participating governments and of other authorized participants. Post-Conference publication and general distribution of the Conference Proceedings will follow United Nations practices as laid down by the United Nations Publications Board.

ANIMAL IMPROVEMENT AND ADAPTATION

Jay L. Lush, Iowa State University, Iowa City, Iowa
Jorge de Alba, Instituto Interamericano de Ciencias Agricolas de la OEA, Turrialba, Costa Rica

1. The first step in any animal improvement program is to describe clearly the characteristics of the ideal animal for the particular region or country concerned, giving due consideration to the nutritional, cultural and other needs of the people. Then, the greatest attention should be given to obtaining direct and simple measurements of productivity, with only minor emphasis on the "sign characters" which might indicate productivity but only indirectly. An individual animal's genetic merit (or breeding value) can be estimated more accurately by considering also the merit of its ancestors, collateral relatives and progeny, and by allowing for the effects of non-standard environment of the individual's own performance, than by judging that animal entirely on its own appearance and apparent performance.

2. Improvement by breeding can follow two somewhat divergent roads. The first and simplest is to select those animals which are best genetically and to use them as extensively as possible for breeding, and to cull, at every opportunity, those which are worst genetically. The first method is aimed at producing a stock which is as good as, or better than, any cross which could be made from it. The second road leads towards relatively pure seedstocks which are mediocre themselves but which will cross with each other to produce better animals for use than any pure stock can be. This second road is advantageous when heterosis is extreme but it may require too much record keeping, too much separation of stocks, and too many other complications to be practical in the less well developed countries. However, it is now the standard practice of maize breeders and of many breeders of poultry. Crisscrossing with two distinct native stocks or with an imported stock and a native stock, is the simplestcontinuing way of following this road with animals. Rotation cross-breeding with three or more such stocks will capture somewhat more of the heterosis but is more complicated.

3. A first step in seeking the most suitable foundation stock is to visit all the farms where native stock has been improved by local breeders. If even a few of these have already improved their animals distinctly, it is an indication that the local stock almost surely contains many other advantageous but hidden qualities.

4. An imported breed is rarely suited perfectly to the local needs. It is common practice to "grade" or breed successive generations of a herd to sires of an improved breed. However, before grading the native stock far toward an imported breed, one should ascertain whether the locally produced purebred females of the imported breed are well adapted. If the purebreds are ill-adapted in any important respects, grading the native stock toward the imported one should generally not proceed further than the first or second cross. Testing the adaptability of an imported stock, when bred pure, costs both time and money. Therefore, it would be

advisable to visit the herds of exotic breeds already in production in countries with similar environments before proceeding with this type of program.

5. If crosses of an imported stock on the native animals are better than the native stock, the cause could be either (1) heterosis or (2) the imported stock is itself intrinsically adapted to that country. It is important to determine as early as possible which of these explains the merit of the first cross. If heterosis is the cause, grading toward the imported stock should not go much further than the first cross. The native stock may have contributed as much to the heterosis as the imported stock. If the first crosses are backcrossed to the imported stock, the 3/4 imported stock which result will have only about one-fourth as much temporary heterosis as the first crosses had and they will also lose much of the local adaptability which the native stock contributed. If, however, heterosis is small and yet the first crosses are superior to the native stock, grading at least one more generation toward the imported stock seems advisable.

6. If each of two or more stocks has different qualities, which are highly advantageous locally and yet heterosis is not extreme, combining these into a single breed may be advisable, although that will require much time. All of the temporary heterosis will disappear in the first generation produced by mating together males and females with the same percentage of blood. One should be prepared for this. The genetic base should be kept reasonably broad at all times. This requires using in each generation a large enough number of sires to ensure that the inbreeding will not rise rapidly.

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SUR L'APPLICATION DE LA SCIENCE ET DE LA TECHNIQUE
DANS L'INTÉRÊT DES RÉGIONS PEU DÉVELOPPÉES

Point de l'ordre du jour : C.5.1

Sénégal

PROPHYLAXIE DE LA PESTE BOVINE

Par Y. GILBERT,
Docteur Vétérinaire,
Chef du Service des Virus au Laboratoire
National de Recherches Vétérinaires
de Dakar-Hann, Sénégal

Les mémoires rédigés à l'intention de la Conférence des Nations Unies sur l'application de la science et de la technique dans l'intérêt des régions peu développées sont des documents de travail. Ils sont publiés tels qu'ils ont été présentés et les assertions et opinions qu'ils contiennent sont celles de leurs auteurs.

NOTES

1. Les mémoires choisis pour être présentés en séance générale pourront être obtenus à la Conférence dans les langues officielles suivantes des Nations Unies: anglais, espagnol, français et russe.

2. Les mémoires choisis pour être présentés en séance spéciale pourront être obtenus à la Conférence dans l'une seulement de ces langues officielles.

3. Les résumés qui ont été rédigés pour tous les mémoires par les auteurs de ceux-ci pourront être obtenus à la Conférence dans les langues officielles suivantes des Nations Unies: anglais, espagnol, français et russe.

4. Préalablement à la Conférence, les mémoires et les résumés ne feront pas l'objet d'une distribution générale mais d'un tirage restreint destiné aux délégations des gouvernements et autres participants officiels. La publication et la distribution générale des actes de la Conférence s'effectueront conformément aux règles et pratiques agréées par le Comité des publications des Nations Unies.

PROPHYLAXIE DE LA PESTE BOVINE

par Y. GILBERT Docteur Vétérinaire
Chef du Service des Virus au Laboratoire National
de Recherches Vétérinaires de Dakar-Hann

La prophylaxie de la peste bovine relève des méthodes de la prophylaxie sanitaire, et de la prophylaxie médicale.

I - Prophylaxie Sanitaire.

Elle est fondée sur l'application de mesures strictes concernant l'abattage des malades et des contaminés (stamping out) la destruction des cadavres et produits virulents, la règlementation de la circulation des troupeaux, la quarantaine, etc.-

Dans les pays possédant une armature sanitaire solide et développée, ces seules mesures permettent l'éradication de la maladie après une introduction accidentelle du contage. La rapidité d'établissement du diagnostic constitue un facteur essentiel du succès et limite, et la zone de diffusion de la maladie, et les frais qu'entraîne l'indemnisation des propriétaires des animaux abattus au titre des opérations prophylactiques.

Par contre dans les régions à faible densité de population humaine et animale, où la peste bovine sévit à l'état enzootique, chez un bétail transhumant sur de longues distances, la prophylaxie sanitaire seule se révèle incapable d'assurer l'éradication de la maladie. La faiblesse des ressources budgétaires interdit le recours à l'abattage systématique des malades, suspects et contaminés, qui implique une indemnisation des propriétaires ; la quarantaine et l'immobilisation des troupeaux infectés ne peuvent être imposés en raison de l'impérieuse nécessité du déplacement à la recherche de pâturages et d'eau.

Rien ne peut donc s'opposer à l'entretien et à la dissémination du contage, et un résultat valable ne peut être acquis qu'au prix de l'immunisation systématique de la totalité de cheptel par les méthodes de prophylaxie médicale.

La réduction de l'incidence de la peste bovine qui en résulte permet alors d'envisager un renforcement des mesures sanitaires, et, par l'action conjointe des deux modes de prophylaxie, d'obtenir enfin l'éradication de la maladie.

II - Prophylaxie Médicale.

A - Le Sérum antipestique

Son emploi est pratiquement abandonné, et rares sont les laboratoires qui en préparent encore. Il ne présente donc qu'un intérêt historique.

B - Vaccins inactivés.

1°/ Modes de préparation

Ces vaccins sont préparés à partir de pulpes d'organes récoltés chez des animaux infectés de peste bovine, rendues avirulentes par l'action d'un antiseptique.

En pratique, on inocule à des bovins réceptifs un virus pleinement virulent. Ils sont sacrifiés à la phase fébrile de la maladie, lors de l'apparition des lésions buccales, avant la phse des lésions internes (diarrhée).

Sont récoltés : la rate et les ganglions. Certains auteurs préconisent également l'utilisation du poumon, du thymus et des amygdales.

Ces organes sont finement broyés, recueillis dans un soluté isotonique additionné d'antiseptique (formol en particulier) et additionnés d'un adjuvant de l'immunité (gel d'alumine ou saponine). Différentes techniques ont été décrites. Les plus récentes font appel au broyage colloidal qui permet d'accroître sensiblement le pouvoir antigénique du vaccin.

2°/ Avantages

Les vaccins inactivés offrent l'avantage d'une parfaite innocuité. Ils peuvent être administrés aux animaux de tout âge et de toute condition, sans provoquer de réactions fâcheuses. Ils sont parfaitement tolérés par toutes les races bovines et confèrent une immunité solide.

De plus, aucun risque d'expansion du virus n'est couru, et ils représentent le procédé de choix dans les régions indemnes de peste bovine accidentellement infectées.

Enfin, ils possèdent des qualités de conservation marquées à des températures même élevées, et leur emploi ne nécessite aucun équipement particulier.

3°/ Inconvénients

Le désavantage majeur des vaccins inactivés réside dans leur prix de revient élevé. Ils nécessitent pour leur préparation l'emploi de bovins réceptifs, et le rendement en doses vaccinales par bovin, malgré le perfectionnement des techniques, demeure faible. Le vaccin est donc grevé au départ du prix d'achat des animaux producteurs de matière virulente. En outre, l'extension des campagnes de vaccination préventive systématique raréfie le nombre des bovins réceptifs qu'il devient de plus en plus difficile de se procurer.

Si l'immunité conférée est solide, elle demande pour s'établir un temps assez long, si bien qu'autour des foyers de peste bovine, l'immunisation par ce procédé des troupeaux avoisinants n'arrête pas rapidement l'extension de la maladie.

La durée de l'immunité conférée n'excède pas six à huit mois. Une intervention annuelle ne suffit pas à procurer une sécurité absolue.

Enfin, ces vaccins s'emploient à dose élevée : 2 à 5 cm3 par animal, ce qui implique pour les immunisations de masse, le transport de quantités considérables de vaccin.

C. Virus atténués

On désigne sous ce vocable des agents immunisants constitués par des virus ayant gardé leur pouvoir infectant et leur pouvoir de multiplication, ainsi que leurs propriétés immunigènes, mais dont le pouvoir pathogène pour le bovin est considérablement réduit, voir disparu.

L'atténuation du pouvoir pathogène pour le bovin s'obtient par propagation du virus chez un hôte naturellement peu sensible : caprins, lapins, oeuf embryonné, ou dans des cultures de cellules.

La répétition des passages chez cet hôte inhabituel aboutit à une modification du pouvoir pathogène du virus bovipestique, qui augmente pour l'hôte occasionnel, et diminue pour le bovin.

En pratique sont utilisés les vaccins modifiés par passage :

sur caprins

sur lapins

sur oeuf embryonné

sur cellules en culture.

1°/ Virus bovipestique caprinisé

Une seule souche est utilisée en Afrique, c'est la souche de Virus qui a atteint plus de 750 passages sur caprins.

a) Le virus chez les caprins

La seule manifestation constante de l'infection chez les caprins réside dans l'hyperthermie qui débute 2 jours après l'inoculation et culmine le 3 ème jour.

Le virus se retrouve dans le sang, la plupart des tissus, les sécrétions et excrétions. La teneur en est maxima au niveau des organes du système réticulo endothéliol, rate en particulier où le titre du virus atteint $10^{5,5}$ à $10^{6,5}$ doses maxima infectantes/caprin par gramme.

La résistance du virus a surtout été recherchée à basse température ; à +5°C le virus du sang se conserve 19 jours. Celui de la rate pendant 40 jours.

b) Le virus chez les bovins

La réceptivité au virus bovipestique caprinisé varie selon de nombreux facteurs dont les plus importants sont la race, l'âge et l'état d'entretien.

Chez les zébus, l'incubation dure en moyenne 3 jours. L'hyperthermie débute alors et culmine au 5 ème jour. Elle décroit rapidement et en quelques jours, la température redevient normale. Chez les animaux hypersensibles apparaissent des signes cliniques analogues à ceux de la peste bovine : larmoiement, jetage, diarrhée. Des ulcérations buccales pourraient être observées selon certains auteurs. D'autres n'en ont jamais observé et considèrent l'absence de lésions buccales comme une caractéristique du virus bovipestique caprinisé.

La mortalité varie essentiellement selon la réceptivité des animaux et leur état d'entretien. Elle peut ne pas dépasser 1 p.100, ou parfois même chez des jeunes zébus atteindre 10 à 20 %.

Enfin, certains animaux guérissent mais conservent de graves séquelles et leur développement ultérieur est fâcheusement compromis.

Le virus caprinisé confère aux bovins une immunité dont l'apparition est précoce et la durée très longue (plus de 10 années).

c) Modes de préparation du vaccin.

i) Vaccin préparé sur caprins

Les caprins réceptifs reçoivent 2 cm3 d'une suspension de virus lyophilisé par voie sous cutanée. L'élévation thermique débute le 7 ème jour, atteint son acme le 3 ème jour hyperthermie de 1,5 à 2°C).

Les animaux sont sacrifiés ; leur rate est prélevée, et, après broyage, lyophilisée et répartie en ampoules.

ii) Vaccin préparé sur bovins réagissants

La source de virus vaccin est représentée dans cette technique par les organes (rate et ganglions) de bovins réceptifs, prélevés à l'acmé de la réaction provoquée par l'inoculation de virus bovipestique caprinisé.

Des bovins réceptifs sans bosse sont inoculés à l'aide de vaccin caprinisé. Leur rate et leur ganglion sont récoltés, mélangés à une quantité égale de sang défibriné, broyés lyophilisés en ampoules.

Ce vaccin présente l'avantage de ne nécessiter la manipulation que d'un nombre restreint d'animaux. Chaque veau fournit en moyenne 100.000 doses de vaccin, ce qui compte tenu du nombre de caprins, non réagissant ou inutilisables exigerait l'achat de 100 à 200 chèvres.

L'économie réalisée est sensible, sur le prix d'achat, les frais de gardiennage et de nourriture des animaux et sur les manipulations en vue de la préparation du vaccin.

2°/ Le virus bovipestique lapinisé.

a) Le virus chez le lapin

Seule est utilisée la souche Nakamura III. Toutes les races de lapins semblent sensibles à l'infection par cette souche.

L'infection par le virus bovipestique lapinisé se traduit essentiellement par une réaction thermique. L'hyperthermie débute après une incubation de 24 à 36 heures augmente jusqu'à la 50 ème heure, se maintient en plateau jusqu'à la 60 ème, et décroit ensuite rapidement. Le maximum thermique est en moyenne de 41°3.

L'hyperthermie par rapport à la température normale est de 1°8 C.

Les autres signes cliniques sont peu marqués : tristesse, anorexie, diarrhée, accélération de la respiration.

Les lésions provoquées par le virus L affectent essentiellement les organes hémolymphopoiétiques : les follicules lymphoides s'hypertrophient se nécrosent et deviennent blanchâtres.

La résistance de ce virus est très faible : Les ganglions en milieu glycériné tamponné gardent leur virulence à +4°C pendant 17 à 20 jours, à +24°C pendant 4 jours, à 31°C pendant 48 heures. A 35°C, le virus survit 8 heures au maximum.

b) Le virus chezle boeuf.

La souche Nakamura III est relativement bien tolérée par la quasi totalité du bétail.

Les zébus ne présentent à la suite de l'inoculation aucune réaction, hormis exceptionnellement une légère hyperthermie ; les bovins sans bosse présentent une hyperthermie légère, n'excédant pas, hors les cas d'exception, 1°5 à 2°C, et les produits de croisement zébus, taurins tolèrent parfaitement ce vaccin.

Exceptionnellement, des réactions graves sont observées.

L'immunité conférée par le virus bovipestique lapinisé est solide, que l'épreuve soit effectuée par contact avec les animaux infectés, ou par inoculation de virus. Elle est acquise même en l'absence de toute réaction organique décelable.

La durée d'établissement de l'immunité varie selon les auteurs de 5 à 8 jours. Passé ce délai, il est pratiquement impossible d'infecter un animal vacciné, quelque soit la dose inoculée de virus d'épreuve.

Cette immunité est durable, et des expériences effectuées en Sierra Léone permettent d'affirmer qu'elle est encore solide après 4 ans.

c) Mode de préparation

Le virus bovipestique lapinisé est obtenu par inoculation intraveineuse dans la veine marginale de l'oreille des lapins pesant en moyenne de 1,5 à 2 kgs de virus d'un passage précédent. Il est utile d'inoculer une assez forte dose de virus (10.000 DMI). La température des lapins est prise matin et soir. Les lapins sont sacrifiés le 7 ème jour suivant l'inoculation (60 à 72 heures plus tard) et l'on recueille le sang (qui est défibriné dans un flacon contenant des billes de verre) la rate et les ganglions mésentériques.

Sang et organes sont aussitôt refroidis pour assurer la conservation du virus.

Le vaccin peut être préparé, soit à l'état frais, soit à l'état lyophilisé.

Le rendement en vaccin sec par lapin est de 600 à 750 doses par lapin pesant 1 Kg 500.

La conservation du vaccin desséché est bonne à -20°C : elle excède 12 mois. Il est donc possible de constituer des stocks à l'époque où l'élevage du lapin donne les meilleurs résultats.

A +4°C, la conservation excède 30 jours mais ce délai doit être, par prudence, considéré comme un maximum, de même qu'en thermos remplie de glace.

Le vaccin conservé à la température ambiante (souvent élevée en régions tropicales) voit son pouvoir immunisant rapidement détruit.

Virus vaccins bovipestiques avianisés

Ils sont cités pour mémoire, car des deux souches B.A. et L.A., mises au point au Japon, aucune n'a pu être entretenue sur oeuf avec succès en Afrique.

4 - Virus bovipestique en cultures cellulaires.

La technique d'adaptation des virus aux cultures cellulaires vient d'être appliquée avec succès à la culture du virus bovipestique, et permet d'espérer à brève échéance la vulgarisation de l'emploi d'une nouvelle méthode d'immunisation des bovins.

Seule une souche est actuellement atténuée et peut être utilisée comme vaccin : c'est la souche Kabete "O", adaptée au Kenya.

Le virus est obtenu par infection d'une suspension fraîche de cellules épithélioles de rein de jeune veau. Ces cellules cultivent en flacons, sont attaquées par le virus et le milieu nutritif est alors récolte, dilué dans un excipient approprié et lyophilisé.

Ce virus a été injecté à des bovins des races les plus sensibles, (race N'Dama par exemple) et, chez les jeunes, la croissance n'a subi aucun retard par rapport à celle de veaux non inoculés.

L'âge, le sexe, l'état d'entretien n'ont aucune influence, le virus est parfaitement toléré, quelle que soit la saison.

En ce qui concerne l'efficacité, l'inoculation à dose convenable de virus de culture, quel que soit le nombre de passages effectués, protège contre une inoculation d'épreuve de virus bovipestique pratiquée 2 à 3 semaines plus tard.

La durée de l'immunité suivant l'inoculation de virus de culture est longue, aussi que l'attestent des expériences qui, en cours depuis 4 ans, n'ont pas encore abouti à l'observation de la fin de l'immunité.

Ce vaccin parait pouvoir devenir dans un avenir proche une arme de choix dans la lutte contre la peste bovine. Il est indispensable, cependant, avant de généraliser son emploi, de multiplier les expériences afin de déterminer si son efficacité, reconnue chez les races bovines les plus fragiles sera suffisante chez les races plus résistantes à la peste, tels les zébus de la zone sahélienne. Des essais extensifs devront être effectués, car il est à craindre que l'atténuation poussée du pouvoir pathogène, recherchée dans le but de minimiser les réactions post vaccinales, n'influe défavorablement sur l'efficacité du vaccin.

Choix d'une méthode de Vaccination

Nombreux sont les facteurs qui conditionnent le choix judicieux d'une méthode de vaccination contre la peste bovine. Ils tiennent essentiellement au milieu, au cheptel, et à l'épizootologie de la maladie dans la zone considérée.

Milieu

Il détermine le mode d'élevage, c'est-à-dire qu'il impose à l'éleveur un mode de transhumance ou au contraire lui permet de conserver les animaux à l'état sédentaire. La prophylaxie médicale de la peste bovine sera totalement différente dans l'un ou l'autre cas. De même, l'équipement en moyens de communication jouera un rôle important de ce choix du vaccin utilisable.

Cheptel

Le nombre d'animaux à vacciner, la densité du bétail, la race, l'état d'entretien l'existence possible de maladies latentes (helminthiases, hémoparasitoses), et la réceptivité du bétail à la peste bovine conduisent à choisir de préférence tel ou tel type de vaccin.

Epizootologie

La peste bovine peut sévir dans la région à l'état enzootique ou avoir été accidentellement introduite, être présente depuis un temps plus ou moins long, son éradication peut être envisagée ou non à brève échéance. Autant de facteurs qui guideront le choix de la méthode prophylactique : la conduite à tenir sera différente selon que l'on recherche l'éradication totale de la maladie ou la limitation des pertes sans envisager la possibilité de l'éradication.

Compte tenu de ces différents facteurs, le choix du vaccin sera déterminé en fonction de son innocuité, de son efficacité de son prix de revient et des conditions de production et d'emploi.

L'innocuité est la qualité essentielle devant être recherchée. Si autrefois l'urgence de la lutte contre la peste bovine pouvait paraître apporter une justification aux pourcentages importants de pertes survenant après vaccination, il n'en est plus de même actuellement, où l'arsenal prophylactique comporte une gamme de vaccins efficaces pouvant convenir à chaque cas particulier.

Il est indispensable d'effectuer dans chaque région devant être soumise à la vaccination des essais études pour déterminer les réactions de la population bovine à tel ou tel type de vaccin, afin de choisir, en connaissance de cause le meilleur. Toutefois, la recherche de l'innocuité ne doit pas conduire à l'utilisation de vaccins vivants au pouvoir pathogène exagérément atténué, et qui risqueraient de se trouver neutralisés dans l'organisme de certains individus pourvus d'une résistance spontanée, raciale ou individuelle ; des échecs de vaccination seraient alors enrégistrés.

L'efficacité des vaccins inactivés est bien connue, on peut leur reprocher la lenteur d'établissement de l'immunité (une quinzaine de jours) qui proscrit leur emploi à proximité immédiate des foyers. De plus, la durée de l'immunité n'excède pas quelques mois, et deux immunisations par an seraient nécessaires à l'entretien de la protection.

Parmi les virus-vaccins, hormis les virus aviarisés, trois donnent de bons résultats. L'immunité conférée est solide, et sa durée atteint plusieurs années. Cependant, l'efficacité des virus vaccins doit être déterminée en fonction du degré d'innocuité. Il est recommandé en effet d'inoculer des quantités assez fortes de virus afin d'obtenir à coup sûr une immunisation rapide, solide et durable.

Le prix de revient des vaccins est un facteur non négligeable : les vaccins inactivés coûtent sensiblement plus cher que les virus vaccins.

Les premiers exigent en effet l'utilisation de jeunes bovins comme source de virus, et compte tenu du faible nombre de doses vaccinales obtenues par sujet (malgré l'amélioration des méthodes de préparation) du nombre d'animaux non réagissants et des pertes inévitables, le prix de revient du vaccin s'établit à un niveau élevé.

Parmi les virus vaccins, les virus bovipestique caprinisé préparé sur bovin réagissant est le meilleur marché. Le virus bovipestique lapinisé coûte nettement plus cher.

Il n'est pas possible de chiffrer encore le prix du vaccin de culture, mais son coût s'établira certainement à un niveau très bas.

Les possibilités de production interviennent également dans le choix du vaccin. Il est possible de préparer à peu près partout du virus bovipestique caprinisé, moyennant un équipement de laboratoire restreint. Par contre, la production de virus vaccin lapinisé est conditionnée par les possibilités de fournitures en lapins, animaux dont l'élevage est relativement difficile en milieu tropical.

Le virus de culture cellulaire nécessité des installations perfectionnées mais la production peut en être implantée dans n'importe quel centre convenablement équipé.

Les conditions sanitaires, règnant dans la zone d'emploi sont également un facteur du choix.

En région habituellement indemne où la peste bovine est accidentellement introduite, si des mesures de prophylaxie médicale doivent compléter les mesures sanitaires, il serai fait exclusivement appel aux vaccins inactivés.

Par contre, dans les régions d'enzootie ou d'épizootie, les virus vaccins trouvent leur pleine justification.

Il n'existe aucun risque de voir se perpétuer une hypothétique infection due à une revitalisation des virus-vaccins et les avantages de ceux-ci l'emportent de beaucoup sur les inconvénients.

Enfin, il faut prendre en considération l'équipement disponible dans la zone à vacciner, pour déterminer en dernier lieu le type de vaccin à utiliser. Les virus vaccins exigent en effet des conditions de conservation très strictes dont l'irrespect entraîne l'inactivation du vaccin.

Il faut qu'il soit possible d'établir une chaîne du froid ininterrompue depuis le laboratoire producteur jusqu'à la séringue du vaccination. Si l'infrastructure et le matériel disponible ne permettent pas cette réalisation, mieux vaut recourir aux vaccins inactivés dont la conservation à température élevée n'altère pas l'efficacité avant une longue période.

- C O N C L U S I O N -

De nombreux vaccins sont utilisables dans la lutte contre la peste bovine ; pour ne rappeler que ceux ayant prouvé leur efficacité au cours de plusieurs années d'emploi, il faut citer les vaccins inactivés dont l'emploi est de plus en plus restreint, puis les virus vaccins parmi lesquels le virus bovipestique caprinisé et le virus bovipestique lapinisé sont les plus utilisés.

Une nouvelle technique, la culture du virus bovipestique en culture tissulaire promet également de fournir un agent immunisant efficace.

Le type de vaccin à adopter doit être choisi dans chaque région déterminée en tenant compte d'un certain nombre de facteurs - sensibilité des bovins à la peste bovine, mode d'élevage, personnel et équipement disponibles sont les plus importants.

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FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

SUMMARY

Agenda Item: C.5.1

Senegal

CATTLE-PLAGUE PROPHYLAXIS

By Y. GILBERT,
Veterinary Surgeon,
Head of Virus Service,
National Research Laboratory,
Dakar-Hann, Senegal

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CATTLE-PLAGUE PROPHYLAXIS

By

Y. GILBERT, VETERINARY SURGEON, HEAD OF VIRUS SERVICE, NATIONAL RESEARCH LABORATORY, DAKAR-HANN, SENEGAL.

Medical prophylaxis of cattle-plague makes use both of passive and active immunisation processes.

Passive immunisation is applied by means of anti-plague serum, the use of which has been practically stopped.

Active immunisation uses vaccines which can be classified in two groups:

Inactivated vaccines

Host-produced attenuated virus vaccines

Inactivated vaccines are prepared from the pulp of organs of infected animals and treated with an antiseptic, generally formol.

This type of vaccine is undeniably effective and innocuous. It produces no undesirable reactions even in the most sensitive races. Disadvantages claimed are the slow development of immunity and its short duration, once developed, and especially the high cost.

Among virus vaccines, the cattle-plague virus vaccines produced from goat or rabbit organs are the most widely used.

The goat type vaccine is prepared either from goat or cattle organs. The virulent organs are ground and lyophilised.

This vaccine should be reserved for zebus, excluding humpless (taurine) cattle and zebu-cattle crossings. In young animals vaccinated for the first time it produces strong reactions, and a certain percentage of mortality among animals in poor condition. On the other hand, this vaccine confers early and lasting immunity. Its cost is extremely low.

The rabbit-produced cattle-plague virus vaccine is prepared from organs of rabbits infected with Nakamura III strain, ground and lyophilised. This vaccine also confers early, good and lasting immunity. With very few exceptions, it can be used for inoculating hump-less cattle.

Its cost is not very high, but its preparation depends on the facilities for rabbit breeding. This vaccine is very sensitive to heat, and must under all circumstances be stored at a low temperature.

A new vaccine is at present being tested; this is a vaccine obtained by a modification of the cattle-plague virus in living cell cultures.

This vaccine should have the advantages of being cheap, effective, and perfectly innocuous. Tests will be necessary, however, before its use on a large scale can be recommended.

Selection of the vaccine to be used depends on the facilities for its production, method of raising and sensitivity of the cattle to be immunised.

Many factors must be considered to prevent post-vaccination troubles and cessation of immunity.

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Agenda Item: C.4.1

United States of America

PRINCIPLES OF PLANT GENETICS AND THEIR USE IN INCREASING FOOD PRODUCTION

By W.M. MYERS,
Professor and Head,
Department of Agronomy and Plant Genetics,
University of Minnesota,
St. Paul, Minnesota

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PRINCIPLES OF PLANT GENETICS AND THEIR USE IN INCREASING FOOD PRODUCTION

W. M. Myers, Professor and Head
Department of Agronomy and Plant Genetics
University of Minnesota, St. Paul, Minnesota

Introduction

1. Improved varieties of crop plants, developed by application of genetic principles, provide increases in total yield of food, feed or fiber; reduce production losses caused by diseases, insects and other hazards; improve nutritive and industrial values of the crops; facilitate introduction of the crop into new areas; and reduce production costs through greater efficiency of fertilizer usage, easier culture and harvest and adaptation to mechanization. Plant breeding provides short-term benefits from use of superior local seed sources or introduced varieties and long-term benefits through development of varieties specifically designed for local soil, climatic and use conditions. In less developed countries, improved varieties have the advantage of requiring, after the variety is developed, little capital outlay by the farmers. Furthermore, experience has shown that improved varieties lead the way to other improvements by the farmers in cultural practices, irrigation, fertilization, and disease and pest control.

Testing Indigenous Materials and Introductions

2. The first step in plant breeding is evaluation of already existing materials. These include such indigenous materials as local varieties, farmers' seed lots and natural stands, as well as varieties and collections from other areas of the world. These materials frequently enable the plant breeder to identify varieties that can be increased and distributed without further breeding work and to assess the characteristics of the crop which are most in need of improvement. Large differences among seed lots in different villages and among farmers' lots in the same village may be expected, and distribution of the best varieties can have an important impact within a short time on crop production in the country. For example, in Thailand approximately 40 rice varieties had been identified as standard government varieties. In an expanded breeding program these varieties were tested at several locations with the striking result that the best standard variety produced up to 80 percent more than the poorest. Recognizing that the varieties in these official trials represented only a small sample of the wealth of types among farmers' seed lots, 3000 "varieties" were collected from various parts of Thailand. After four years of testing, the best collected seed lots exceeded the superior standard variety by 16 to 40 percent at one location.

3. Another important potential source of "ready made" varieties which can be put to use quickly in the developing country is introduction of varieties from other areas of the world. Agro-climatic analogues exist between various countries, and varieties adapted in one country may in general be expected to be adapted in another with similar ecological conditions. The first varieties of cereal crops, clovers, alfalfa, soybeans and many other crops in the United States were direct introductions from Europe, the Near East and East Asia. Introductions have played an important part in "filling the gap" with useful varieties in many countries while the somewhat

slower formal breeding programs were developing specifically adapted superior varieties.

4. In postwar Europe the hybrid corn production program began on the foundation of certain U. S. hybrids several years before it could have been based on hybrids specifically bred for the various European conditions. In a like manner, U. S. maize hybrids were found to be superior in yield to desai corn in parts of India; although the difficulty of maintaining the inbreds and producing the single crosses made them unsuitable for Indian conditions, nevertheless their superiority helped to pave the way for the Indian Coordinated Maize Breeding Scheme and, here again, plant introduction played a key early role. The first four double cross hybrids, now being introduced only four years later, are from crosses involving, in various combinations, three inbreds of Indian origin, three from U. S. germplasm, and four of South American origin. These four hybrids produce yields of 122, 142, 151 and 153 percent of the best local strains in the areas for which they are released.

5. In the United States "World Collections" of wheat, oats, barley, corn, rice, soybeans, flax, alfalfa, and several other crops are maintained on a systematic basis. The plant breeder in a developing nation can tap this resource of germplasm by writing to the Agricultural Research Service, U. S. Department of Agriculture, or the United States A.I.D. Mission in his own country.

Plant Breeding Procedures

6. Once suitable breeding materials have been identified, the breeding objectives clarified, and, if possible, progress made on increasing and distributing "stop gap" varieties, a more formal plant breeding program can be initiated. There are three basic steps in plant breeding; namely, (a) finding or developing suitable populations within which effective selection can be practiced; (b) selection, including evaluation of the selections; and (c) use of the selections to produce varieties for distribution to the farmers.

Finding or Developing Populations for Selection

7. A suitable population for selection is one which has sufficient genetic variability and within which the genes desired in the new variety occur in high enough frequency to permit the recovery of combinations of them in populations of feasible size. The plant breeder is, in general, limited to the genes that are available in the populations which he has. Furthermore, frequencies of the desirable genes are important in the effectiveness with which the plant breeder can select for combinations of them. Although much progress can be made by selection in existing populations, particularly in the early stages of the breeding program, greatest ultimate progress can be expected by developing populations which have combinations of genes and gene frequencies which lead to most effective progress by selection. A number of breeding methods or mating systems are available. These include hybridization, inbreeding, backcrossing, recurrent selection, and reciprocal recurrent selection. These methods are treated in some detail in recent plant breeding textbooks, including those by Hayes, Immer and Smith; Elliott; Poehlman; and Allard.

8. Hybridization is the most powerful tool for creating source populations. The segregation and recombination that occur following hybridization result in extensive genetic variability, a prerequisite to successful selection. Controlled hybridization between parents of known performance has been used extensively in the more advanced breeding programs with the self-pollinated crops. In cross-pollinated crops, where genetic variability in natural populations is very high, controlled hybridization has been less essential. Nevertheless, hybridization between selected inbred lines of maize has been an effective means of producing new populations from which superior inbreds can be extracted. Intervarietal hybrids and crosses between

non-inbred clones have also been used in alfalfa, Hevea, cacao, fruit crops and other cross pollinators.

9. Inbreeding results in rapid increase in homozygosity and segregation of the population into lines with varying degrees of relationship to one another. In the naturally self-pollinated species, in which inbreeding by selfing occurs normally, populations which develop following hybridization consist, after a few generations, of predominantly homozygous plants. A practical level of homozygosity is reached by the F_5 to F_8 generations. Breeders of the self-pollinated species differ regarding steps to follow between hybridization and the point of relative homozygosity. Proponents of the pedigree method use visual selection of individual plants in each generation and of the progenies of these selected individuals in each succeeding generation. By F_5 to F_6, the remaining lines are but a small sample of the total genetic recombinations that would be found in a corresponding unselected population. Hopefully, this selected sample will have a substantially higher frequency of favorable genes than the unselected population. Proponents of the bulk method do not attempt to apply selection pressure on the population during the several generations between hybridization and the time of relative homozygosity. Shifts in gene frequency in such populations are the results of drift or natural selection. Selection by the plant breeder is started in F_6, F_7 or F_8. Neither the pedigree nor the bulk method is clearly superior in all circumstances. Choice of the time at which selection pressure should be applied depends upon a number of factors, including mode of inheritance of the most important characters, the facilities available to the plant breeder, and his knowledge and skill.

10. Inbreeding, usually by enforced self-pollination, is commonly used in the naturally cross-pollinated crops. The objectives are to (a) speed up increase in frequency of desirable genes and (b) to develop lines that can be reproduced from seed through successive generations of evaluation and subsequent use in the breeding program. Where selection for favorable genes can be effectively made on the basis of the individual plant or selfed progeny, inbreeding by selfing provides the most rapid method of obtaining lines that are homozygous for such genes. On the other hand, there is evidence that inbreeding with visual selection is relatively ineffective in raising the average frequencies of desirable genes for such characters as combining ability for yield. Because of the urgency for producing improved maize varieties as rapidly as possible, the first hybrids distributed in Mexico were produced from four S_1 lines. Use of lines inbred for additional generations resulted in more uniform hybrids but little improvement in yield over the hybrids was made from S_1 lines. Although there may be advantages in more inbreeding, it seems obvious that improved maize yields that can come from hybrids should not be delayed by a long inbreeding program.

11. Backcrossing results in a rapid and predictable shift of gene frequencies in the population, following hybridization, toward the genotype of the recurrent parent. When continued for sufficient generations, all plants of the population theoretically will have the same genotype as the recurrent parent except for genes from the non-recurrent parent retained by deliberate selection. Backcrossing is an appropriate tool when one of the parents is superior in a number of characteristics while the other parent is deficient in most. For example, results with rice in Colombia indicate that backcrossing may be expeditious in producing adapted varieties with resistance to the hoja blanca disease. Certain introduced varieties, including Bluebonnet 50, have proved to be superior varieties for use as recurrent parents.

12. Recurrent and reciprocal recurrent selection are effective methods of increasing desirable gene frequencies in populations while retaining a high level of heterozygosity and genetic variability. In this respect, these methods contrast with inbreeding where, through rapid progress toward homozygosity, genetic variability, and hence further progress through selection is rapidly reduced. Success with these procedures

has been reported in breeding maize, Melilotus officinalis and Lolium perenne. A major potentiality of recurrent selection for use in developing countries is that the new population developed at the end of each cycle may, if desired, be increased as a synthetic variety. Such a procedure is being used successfully in Colombia in development of improved synthetic varieties of maize.

Selection

13. Success in plant breeding, once suitable source populations are available, is dependent upon the effectiveness of selection. In order to maximize the effectiveness of selection, the plant breeder must seek to reduce the differential environmental effects to a minimum, relative to the genetic differences in the population. He has several means for doing this including (a) special measures for control of the environment and for insuring as nearly as possible uniform environments for all plants in the population, (b) appropriate experimental designs to reveal differences, control and measure error, and to provide a valid estimate of significance of the differences, and (c) use of selection units appropriate for the characters for which selections are made.

14. One of the simplest and frequently neglected methods for reducing environmental effects is by good cultural practices, good stands and uniform fertilization. These are inexpensive practices that are within the grasp of any plant breeder. The breeder of a crop cannot hope to be successful until he has learned how to grow the crop. Other steps to reduce environmental effects include special disease nurseries and controlled insect infestations in which uniform disease or insect distribution is fostered by various techniques. Finally, the breeder may find use for special facilities for control of photoperiod, light intensity, humidity and temperature in greenhouses or environment control rooms. Since much progress can be made in breeding by less expensive equipment, the plant breeder in the developing country usually will not require such equipment, at least for a number of years.

15. In the self-pollinated crops, in which the relatively homozygous selections are increased to become the varieties of commerce, the selection unit is normally the plant itself or its selfed progeny. In the cross-pollinated crops, on the other hand, the selections normally are used for development of synthetic or hybrid varieties. Since the selections are to be used in hybrid combinations, they usually may be evaluated most effectively in some kind of hybrid combination. The usefulness of tests for general and specific combining ability, the efficacy of early versus delayed testing, the most efficient tester parents to use, and other problems related to evaluation of selections are dealt with extensively in the plant breeding literature. The interested reader is referred to such books as Hayes, Immer and Smith and to many recent journal articles.

Use of Selections

16. In the naturally self-pollinated crops, selections usually are increased through successive generations to become the varieties of commerce. Exception to this is found in some crops, tomatoes for example, in which ease of producing hybrid seed and the relatively small amount of seed required make the use of F_1 hybrids feasible. In vegetatively propagated species, such as potatoes and sugar cane, the varieties used commercially are clones of the original selections. Selections, whether families, inbred lines or clones, of the normally cross-pollinated crops are used in the development of synthetic varieties or as parents of single, three-way or double-cross hybrid varieties.

17. The striking success of hybrid maize in the United States has focused attention of plant breeders on the potentialities of using maize hybrids in other areas of the world and of using hybrid varieties of other crops as well. Maize hybrids were introduced soon after the war in Eruope and much European maize production is now based on hybrids. Maize hybrids have also been developed and distributed for use in Mexico, Colombia, India, and several other countries. In Mexico, in 1960, a new maize hybrid, H-507, was released which yields 20 per cent more than the pre-

viously recommended hybrid, H-503, and about 35 per cent more than the best open-pollinated native varieties in the area. Yield increases of similar magnitude are being obtained from new maize hybrids in Colombia and in India.

18. Although the best hybrid varieties will yield more than the best synthetic varieties that can be produced, difficulties are frequently encountered in adequate scale production of hybrid seed. This is especially true in some developing countries where neither private nor public institutions are available for an orderly process of seed increase and distribution. In such situations, synthetic varieties of maize may prove to be an acceptable solution at least until the procedures for hybrid seed production on an adequate scale can be developed. Much of the improved maize seed used in Mexico is from advanced generations of double cross hybrids. These synthetics have approximately one-half the yield superiority over open-pollinated varieties that the hybrids have. Extensive breeding programs are in progress in Mexico and Colombia on the development of superior synthetics by combinations of several inbred lines and by recurrent selection. In other crops where hybrid seed is not readily produced, synthetic varieties are likewise the means for using selections. The development of synthetics in forage grasses and legumes has been very successful. Controlled hybridization between non-inbred clones has also been used in Central and South America in rubber and cacao.

Cooperation in Plant Breeding

19. Cooperation is one of the most important factors in a successful plant breeding program. This includes cooperation among scientists of different disciplines within the same organization and among scientists of the same discipline in different organizations, stations and countries.

20. Dr. H. K. Hayes, Emeritus Professor of Agronomy and Plant Genetics, University of Minesota, has at different times helped with development of plant breeding programs in China, Chile and The Philippines. In each case, he gave major emphasis to the development of cooperation among research workers and it is probable that this was the most permanent of the many contributions he made. The remarkable agricultural progress in Taiwan is, at least in part, attributable to excellent cooperative and coordinated research and development programs. This cooperation may well be a legacy of the understandings which Hayes helped the Chinese scientists reach on the mainland almost 30 years ago.

Seed Production and Distribution

21. Plant breeding does not contribute to increased food production until seed of the improved varieties are generally available to the farmers. Experience in many countries, including the United States, has shown that seed increase and distribution do not take care of themselves automatically. When small lots of seed of a new variety are distributed and there is no organized effort to guide further increases, the variety is soon lost or the seed becomes mixed with other types.

22. The procedures and organizations for orderly increase and distribution of seed of improved varieties vary considerably among countries. For varieties developed by public agencies, the usual procedure is for a government agency, frequently the plant breeding station, to maintain the "breeder seed" and to produce the "foundation seed". From this stage, procedures vary between the extremes of (a) having all seed of subsequent classes, which will be used by farmers for commercial planting, produced by private seed growers and (b) having all seed of subsequent classes produced and distributed by government seed farms. Any one system of seed production and distribution will not be best for all situations. Instead, the system used must be fitted to the needs and conditions of the country. Nevertheless, the following principles are suggested as guides in devising the seed production and distribution system:

(a) The breeder seed can best be maintained under the close supervision of the plant breeder who developed the variety.

(b) Reliable planting stock (foundation and registered seed) must be available in sufficient quantities for production of the seed that the farmer plants for his commercial crop. This requires some kind of organized program, either public or private.

(c) For production of large quantities of certified seed, private producers are usually more efficient than government seed farms.

(d) Government subsidy of the price of seed of improved varieties does not, in the long run, result in as much farmer acceptance of the improved varieties as when he must pay a premium price for the seed.

- (e) There is need for a certification program, by government or private agency, to insure maintenance of varietal identity and purity.

Special Methods of Breeding

23. Numerous special methods of breeding are available, including transfer of genes from related species, chromosome doubling, use of monosomic and nullisomics, and induction of mutations by radiation. Use of ionizing radiations and other mutagens has attracted the attention of plant breeders as a new tool. Enthusiasm has been particularly high in areas where conventional plant breeding is less well developed and where needs for increased food production are great. Mutation breeding has been grasped as a sort of magic carpet by which the plant breeder can hope to span, in a few years, the developments by conventional plant breeding in other areas during half a century. A quotation from a recent symposium is particularly relevant for less developed countries:

> "As a general rule, the plant breeder cannot afford to adopt it (mutation breeding) today as a breeding method. To do so will result in wasting the time and facilities so used. The plant breeder who studies mutation breeding must do so primarily to evaluate and develop the tool. Unless he has more than sufficient resources for plant breeding by conventional methods, he cannot afford to divert part of his resources to mutation breeding".

24. The same conclusion seems appropriate in general for other highly specialized tools of breeding. There is so much to be done and the potentials for development by conventional plant breeding procedures are so great that efforts in the developing countries should be concentrated primarily on them.

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FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

SUMMARY

Agenda Item: C.4.1

United States of America

PRINCIPLES OF PLANT GENETICS AND THEIR USE IN INCREASING FOOD PRODUCTION

By W.M. MYERS,
Professor and Head,
Department of Agronomy
and Plant Genetics,
University of Minnesota,
St. Paul, Minnesota

Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

NOTES

1. Papers selected for inclusion in General Sessions will be available at the Conference in the following official languages of the United Nations: English, French, Russian and Spanish.

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No. 719

PRINCIPLES OF PLANT GENETICS AND THEIR USE IN INCREASING FOOD PRODUCTION

C.4.1.

W. M. Myers, Professor and Head
Department of Agronomy and Plant Genetics
University of Minnesota, St. Paul, Minnesota

SUMMARY

1. Applied genetics or plant breeding has been one of the most effective sciences available for increasing productivity of crop plants. Improved varieties, developed by application of genetic principles, provide increases in total yield of food, feed or fiber; reduce production losses caused by diseases, insects and other hazards; improve nutritive and industrial values of crops; facilitate introduction of the crop into new areas; and reduce production costs through greater efficiency of fertilizer usage, easier culture and harvest and adaptation to mechanization. Plant breeding provides short term results from use of superior local seed sources or introduced varieties and long term results through development of varieties specifically designed for local soil, climatic and use conditions. In less developed countries, improved varieties have the advantage of requiring, after the variety is developed, little capital outlay by the farmers. Furthermore, experience has shown that improved varieties lead the way to other improvements by the farmers in cultural practices, irrigation, fertilization, disease and pest control.

2. The first step in plant breeding is evaluation of existing materials, including indigenous varieties, farmer's seed lots, natural stands and introductions from other areas of the world. Such trials enable the breeder to make rapid improvements through identification of varieties that can be increased and distributed without further breeding. Extensive collections of the world germ plasm of various important crops are available in the United States and other countries.

3. Once suitable breeding materials have been identified, the breeding objectives have been clarified, and, if possible, progress has been made on increasing and distributing superior existing varieties, a more formal breeding program can be initiated. There are three basic steps in breeding, namely, (a) finding or developing suitable populations within which effective selection can be practiced, (b) selection, including evaluation of the selections, and (c) use of the selections to produce varieties for distribution to farmers.

4. In early stages of the program, indigenous varieties, farmer's seed lots, natural stands and introductions provide suitable populations within which effective selection is possible However, the plant breeder can make greatest ultimate progress by developing populations which have combinations of genes and gene frequencies permitting greatest progress by selection. By hybridization of carefully selected parents, presence of desired genes in the population can be assured. Frequencies of desirable genes may be increased by various mating systems including inbreeding, backcrossing, recurrent selection and reciprocal recurrent selection.

5. Success in breeding, once suitable source populations are available, is dependent upon effectiveness of selection. To maximize effectiveness of selection, it is necessary to reduce differential effects of environment to a minimum relative to genetic differences in the population. This may be accomplished by (a) special measures to assure as nearly as possible uniform environments for all plants in the population, (b) use of appropriate experimental designs to reveal differences, control and measure error and provide a valid estimate of significance of the differences, and (c) use of selection units appropriate to the characters for which selections are made. It is emphasized that one of the simplest and frequently neglected methods for reducing environmental effects is by good cultural practices, good stands and uniform fertilization. The selection unit to be used depends upon heritability of the important characters. For those with high heritability, effective progress can be made by selection of individual plants or clones. Conversely, for characters of low heritability, selection must be based upon a progeny test if it is to be effective. In the self-pollinated crops, the selection unit is normally the plant or its selfed progeny. In naturally cross-pollinated crops, selections usually are evaluated in some kind of hybrid combination. These include top crosses or polycrosses for evaluating general combining ability and diallel crosses and crosses with specific lines or clones to assess specific combining ability and to identify the best specific combinations.

6. Selections in naturally self-pollinated crops usually are increased through successive generations to become the varieties of commerce. In naturally cross-pollinated crops, selections are used in development of synthetic varieties or as parents of hybrids.

7. The importance of cooperation in plant breeding is stressed.

8. A breeding program cannot contribute to increased food production until seed of the improved varieties is generally available to the farmers. Procedures and organizations for orderly increase and distribution of such seed are required.

9. Breeders in developing countries usually will contribute most through use of conventional breeding methods. Usefulness of special methods such as radiation, interspecific gene transfer and polyploidy is restricted to particular situations and normally should not be used except as adjuncts to a strong breeding program.

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